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ANNOTATED BIBLIOGRAPHY: THE EFFECTS OF ATMOSPHERIC POLLUTION ON THE HEALTH OF MAN

Cincinnati University
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THE EFFECTS OF ATMOSPHERIC POLLUTION ON THE HEALTH OF MAN

1957

From the

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and Industrial Health
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INTRODUCTION

Much has been written throughout the years on the effects of air pollution on the health of man. Generally, the publications have been discussions or expressions of opinion concerning the existing conditions and how they may affect human beings. Until relatively recently, extensive medical investigations have been made only as a result of major catastrophes - or acute episodes - which occurred. one of them in 1930 (Meuse Valley), one in 1948 (Donora), one in 1950 (Poza Rica) and one in 1952 (London). The growing concern with air pollution arising from the growth of industrial activity, the resultant shift in population from rural to urban areas, and an increase in the number of motor-driven vehicles, has led in recent years to serious investigations, seeking to determine whether air pollution causes chronic disease in man, and if so, what specific agents can be incriminated.

In the preparation of this bibliography, the aim has been to gather the publications concerned with the physiological effects of the pollution of the general atmosphere. It has seemed desirable to gather in addition to the reports on the major disasters and epidemiologic investigations, articles dealing with statistical findings of morbidity and mortality in which there is some mention of the incidence of diseases within urban versus rural areas. Several fairly extensive analytical surveys of atmospheric pollutants in various cities have also been included, so as to provide ready access to some of the data which have revealed the present extent of the contamination of the air with a number of materials and chemical compounds.

The abstracts covering the categories described above are grouped under five main headings.

Section I comprises investigations of conditions applying to communities: Investigations of the major disasters, surveys of the levels of atmospheric contaminants, and statistical and epidemiologic surveys of prevalence of disease. Section II represents discussions, reviews, symposia, editorial comments, news items, books and bibliographies dealing with air pollution and its effects on the health of man.

Until recently, relatively few experimental investigations have dealt directly with the effects of air pollutants on human health. Observations on human subjects have been grouped under Section III, Studies of the Individual. Included under this category are also clinical reports of cases of accidental poisoning, or of chronic effects observed in the working population during or following exposure to gaseous contaminants. These provide background for the appraisal of the incidence of time and concentration (dosage) upon the elicitation and severity of the effects.

Under Section IV are listed experiments with animals. These investigations deal directly with general atmospheric pollutants and with those encountered in the working man's environment. Most of the references under III and IV have been selected from those given as bases for establishing threshold limits in the occupational environment. They have been limited almost entirely to exposure by inhalation.

Since progress in the understanding of the effect of community air pollution on human beings would appear to depend greatly upon the development of more meaningful and precise techniques for the appraisal of pulmonary function and for the diagnosis of diseases of the respiratory tract, with special emphases upon tests which can be carried out in the field, a number of articles dealing with cardiorespiratory efficiency and the testing of pulmonary function have been listed under Section V.

In general, the abstracts have been designed to be informative, and to represent summaries of the investigations, rather than brief annotations. The originals have been consulted in most cases. Where an existing abstract has been used, proper credit has been given.

The sources consulted have been existing bibliographies, books, and reviews on the subject of air pollution, Chemical Abstracts, Biological Abstracts, Bulletin of Hygiene, Current List of Medical Literature, Industrial Hygiene Digest, as well as the periodicals in the library of the Kettering Laboratory.

It has not been the aim to make this a comprehensive general bibliography. Rather, a specific effort has been made to include all published reports of medical investigations of the effects of air pollution upon man. On the other hand, only the more recent discussions have been included. Mandatory limitation of time did not permit a thorough check of the inclusiveness of all pertinent material.

In a compilation of this type, it is inevitable that publications similar in scope may have been placed under different major headings. Where such overlapping has been obvious in the final indexing, cross-references have been provided both at the end of each section and in the subject index. The subject index is detailed and descriptive. Emphasis has been laid on the substances occurring in the atmosphere and their effects on the different systems of the body. The engineering aspects, such as types of equipment used, have not been entered individually.

The index has been prepared on the basis of information contained in the abstracts and for this reason does not include all details within the individual publications.

This survey was initiated in the hope that the general problem would be clarified to a considerable extent, and that definite lines of experimental attack upon its several facets would be revealed. Unhappily, this hope has not been realized, except to the extent that some of the difficulties that lie ahead have been envisioned more clearly, and the scope of the work that must be done to keep pace with the problem has been apprehended more fully. It is evident that a sound understanding of the present and impending situation, in terms of practical measures which can be expected to appraise and maintain the present and future health and comfort of the population of a mechanized and industrialized nation is yet to be achieved. The experimental work toward this end, while considerable in scope and volume, is only the beginning. Certainly, the expenditures of effort, skill and funds which will be required to appraise and control the changing environment of a complex technologic society must be intensified in quantity and quality, so as to be comparable in their adequacy and scope with those which are being applied in bringing about man's new environment. As it stands, this compilation of experience and experiment may serve, for the time, as a reference manual for those who are engaged in or are entering this field of investigation.

May 25, 1957

ABBREVIATIONS, SIGNS AND FORMULAS USED IN ABSTRACTS AND INDEX

A.C.G.I.H.	American Conference of Governmental Industrial Hygienists
AEC	Atomic Energy Commission
AlF_3	aluminum fluoride
Al_2O_3	alumina
As_2O_3	arsenic trioxide
av.	average
BAL	dimercaptopropanol
$BeCl_2$	beryllium chloride
BeF_2	beryllium fluoride
$Be(OH)_2$	beryllium hydroxide
$BeSO_4$	beryllium sulfate
Br_2	bromine
C	carbon
c.	curie
ca.	(about) circa
c.c.	cubic centimeter
CCl_4	carbon tetrachloride
$CHCl_3$	chloroform
CHI_3	iodoform
CHOH	formaldehyde
CH_2O	formaldehyde
CH_4	methane
CO	carbon monoxide
$COCl_2$	phosgene
COHb	carboxyhemoglobin
CO_2	carbon dioxide
concns.	concentrations
CS_2	carbon disulfide
C_2H_2	acetylene
C_2H_5OH	ethyl alcohol
$(C_2H_5)_2O$	ethyl ether
C_3H_5	allyl compounds
$C_6H_5NH_2$	aniline
$C_6H_5NO_2$	nitrobenzene
C_6H_5OH	phenol
C_6H_6	benzene
$CaCO_3$	calcium carbonate
CaF_2	calcium fluoride
CaO	calcium oxide
$Ca(OH)_2$	calcium hydroxide
$CaWO_4$	calcium tungstate
$Ca_3(PO_4)_2$	tricalcium orthophosphate
Cd	cadmium
Ce	cerium
CeO_2	ceric oxide
Cl_2	chlorine
Co	cobalt
Cr_2O_3	chromium sesquioxide
CuO	copper oxide
da.	days
disc.	discussion
ED	effective dose
e.g.	for instance
E.N.T.	ear, nose and throat
F_2	fluorine
FeO	ferrous oxide
Fe_2O_3	ferric oxide
ft.	feet
G.I. tract	gastro-intestinal tract
gal.	gallon
g.	gram
HCHO	formaldehyde
HCN	hydrogen cyanide
HCOH	formaldehyde
HCO_2H	formic acid
HCl	hydrochloric acid
HF	hydrogen fluoride, hydrofluoric acid
HNO_2	nitrous acid
HNO_3	nitric acid
H_2C_2	acetylene
H_2CO_3	carbonic acid
H_2F_2	hydrogen fluoride, hydrofluoric acid (gas)
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
H_2SO_3	sulfurous acid
H_2SO_4	sulfuric acid
H_2Se	hydrogen selenide
H_3P	phosphine
Hb	hemoglobin
He	helium
Hg	mercury
hrs.	hours
i.e.	that is
i.n.	intranasal
i.p.	intraperitoneal
i.t.	intratracheal
i.v.	intravenous
K	potassium
km.	kilometer
KOH	potassium hydroxide
l.	liter
L.A.	Los Angeles
lb.	pound
LC	lethal concentration
LD	lethal dose
LT	lethal time
m.	meter
$m.^3$	cubic meter
MAC	maximum allowable concn.
Mev.	million electron volts
MeOH	methyl alcohol
mg.	milligram
Mg	magnesium
MgO	magnesium oxide
min.	minutes
ml.	milliliter
MLD	minimum lethal dose
MMD	median mass diameter
Mn	manganese

MnO_2	manganese dioxide
Mn_2O_3	manganese sesquioxide
mo.	months
MoO_3	molybdenum trioxide
MPPcf	million particles per cubic ft.
MTC	maximum tolerated concentration
MTD	maximum tolerated dose
N	nitrogen
N_2	nitrogen (gas)
NH_3	ammonia
NH_4Cl	ammonium chloride
NH_4F	ammonium fluoride
$(NH_4)_2S$	ammonium sulfide
NO	nitrogen oxide or nitric oxide
NO_2	nitrogen dioxide
NO_3	nitrogen trioxide
N_2O	nitrous oxide
N_2O_4	nitrogen tetroxide
N_2O_5	nitrogen pentoxide
NaCl	sodium chloride
NaF	sodium fluoride
$NaHCO_3$	sodium bicarbonate
$NaNO_2$	sodium nitrite
$NaNO_3$	sodium nitrate
Na_2CO_3	sodium carbonate
Na_2CrO_4	sodium chromate
$Na_2Cr_2O_7$	sodium dichromate
Na_2SO_4	sodium sulfate
NiO	nickel oxide
O_2	oxygen
O_3	ozone
PCl_3	phosphorus trichloride
PCl_5	phosphorus pentachloride
PM	particulate matter
PO_4	phosphate
$POCl_3$	phosphoryl chloride
ppm	parts per million
pphm	parts per hundred million
P_2O_5	phosphorus pentoxide
$PbBr_2$	lead bromide
$Pb(C_2H_5)_4$	tetraethyl lead
$PbCO_3$	lead carbonate
PbO	lead monoxide
r.	roentgen(s)
RBC	red blood cells
Rn	radon
resp.	respectively
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SO_4	sulfate
Sb	antimony
Sb_2O_3	antimony trioxide
s.c.	subcutaneous
sec.	second(s)
SiF_4	silicon tetrafluoride
SiO_2	silica
SnO_2	tin oxide
sq. mi.	square mile
subj.	subject(s)
t.b.	tuberculosis
Te	tellurium
TEL	tetraethyl lead
TEPP	tetraethylpyrophosphate
TiO_2	titanium oxide
Tn	thoron
Tritox	trichloroacetonitrile
U	uranium
UO_2	uranium dioxide
U_3O_8	uranium tritaoctoxide
UV	ultraviolet
V_2O_5	vanadium pentoxide
viz.	namely
wk.	week(s)
yr.	year(s)
$Zn(NH_4)_2(SO_4)_2 \cdot H_2O$	zinc ammonium sulfate
ZnO	zinc oxide
ZnS	zinc sulfide
$ZNSO_4 \cdot H_2O$	zinc sulfate
$>$	greater than
$<$	less than
$\geqq$	equal to or greater than
$\leqq$	equal to or less than
μ	micron
μc	micro curie
μg	microgram

I. COMMUNITY STUDIES --

Fog Disasters; Surveys of Atmospheric Contaminants; Statistical and Epidemiologic Studies.

1. Cohen, J.B.: The air of towns. Annual Report of the Board of Regents, Smithsonian Inst. 50:349-87, 1895.

This is a series of 4 lectures entitled: 1) Close Rooms, 2) Smoke, 3) Town Fog and 4) The Germs of the Air. According to statistics at that time, only 46% as many people lived to be >65 in Manchester as did in England and Wales as a whole, as compared to 94% for ages <25 and 87% for those from 25-65. For the quarter ending Sept. 1893, out of 400 deaths at ages 25-45, 122, the largest number, were due to phthisis and 38, the next largest, were due to pneumonia. The composition of the air is discussed. Besides the 2 main components of the air, carbonic acid from the combustion of coal and gas is found, and in greater amounts in town air, i.e., ca. 0.04-0.07 volume %,than in the country, i.e., ca. 0.03 volume %. H_2SO_3 and an organic "poison" are also given off from the burning of coal and are more offensive than H_2CO_3. The exact nature of the organic component is unknown but is estimated to be 0.001% of town air. The production and prevention of smoke is discussed. By several methods of calculation it is estimated that the minimum amount of 20 tons of soot is given off to the air of Leeds. Of this 1/2 ton falls to the ground of which 20-25 lbs. stick. Analysis of 2 samples of smoke showed it to contain 14-15 % of a "nasty" sticky oil (unidentified). Glass plates were set out - a) 1 at Pool, 9 mi. from Leeds, b) 1 at Yorkshire College, 1 mi. from Leeds and c) 1 at Philosophical Hall in the center of Leeds. After many months of collection c) weighed 24 X that of a) and b), 10 X that of a). Breathing such filthy air must also clog up the air passages of the lungs and give good reason for the high mortality from respiratory diseases. H_2SO_3 which is "rapidly" converted into H_2SO_4 is also harmful. Certainly a concerted effort to eliminate smoke can and should be made. The nature of fog is next discussed. The more dust in the air, the more fog develops. Analysis of town air showed 1,000,000 - 50,000,000 dust particles/in.^{3} air; that of country air - 8,000 - 100,000/ in.^{3} When fog occurs the ordinary contaminants in the air become more concentrated. In Manchester 1892, SO_3 averaged 1-2 mg. /100 m.^{3} air in Sept. and 6-10 mg. in the foggier mo. of Dec. Readings on the outskirts compared with those at the center of town showed 0.7 mg. in Sept. and 12.7 in Dec. on the outskirts and 1.8 and 25.8 (with fog) at the center of town. The sooty oil in the dust particles retards the evaporation of fog. Some sickness and mortality statistics for Manchester during Dec. 1890 and Jan. and Feb. 1891 show a correlation of deaths from all causes and from respiratory diseases with foggy weather. The germs of the air and their relation to disease are discussed in the last lecture. Many more germs are found in town than in country air.

2. Fox, L.W.: Relation of smoke-laden atmosphere to diseases of the eye. J. Am. Med. Assoc. 47:384, 1906.

The author noted an increase in the number of patients with external eye disease during the previous 3 years and attributed this increase to the coal dust laden atmosphere caused by the substitution of soft coal for hard. The dust in the air injures the conjunctiva and is deposited on the cornea, thus causing ulcerations or predisposition for infections.

As further sources of air pollution, the author mentions the sanding of the railway tracks, loading of ash carts, dry sweeping of the streets and distribution of sand along the trolley tracks. As a result, inflammations and other eye disorders have been observed, as well as chronic catarrhs, asthma and t.b.

3. Grayson, C.J.: Relation of a smoke-laden atmosphere to diseases of the nose and throat. J. Am. Med. Assoc. 47:384, 1906.

   Within a few months following the discovery of natural gas in Pittsburgh, there was a decrease in the incidence of disease of the upper air passages. (Abst. Heimann, H. et al.: U.S. Public Health Service, 1950.)

4. ✓ Ascher, L.: Coal smoke abatement in England. J. Roy. Sanit. Inst. 28:88-93, 1907.

   The author deals mainly with mortality from pulmonary diseases other than t.b. He concludes from his observations that smoke tends to produce acute pulmonary disease and that it hastens the course of t.b. T.B.-infected rabbits which inhaled coal smoke died in an average of 53 days. Those infected with t.b. but not exposed to the smoke died in 90 days.

   For the City of Manchester there was a reduction in the number of foggy days from 36.8 for the years 1886-1900 to 23.4 for 1901-1905. There was a corresponding decrease in mortality from acute pulmonary disease, especially in children under 1 year. Statistics for urban and rural districts are given for the period 1902-1904, showing that mortality from acute respiratory disease is higher in cities than rural areas. Smoke is, however, one factor in causing acute pulmonary diseases. Other influences are climate, living conditions and the presence of harmful organisms. There is a higher death rate from respiratory disease for industrial workers in smoky atmospheres than for rural agricultural laborers. It is 32.6-65.6/ 1,000 living in industrial areas and 18.6/ 1,000 for those living in agricultural areas. (Abst. Heimann, H. et al.: U.S. Public Health Service, 1950.)

5. ✓ Ascher, L.: Smoke-nuisance in large towns. Eng. News 58:434-5, 1907.

   The following facts speak for the injuriousness of smoke and soot: (1) The increase in mortality due to acute pulmonary diseases which is to be observed in many civilized countries was greatest in industrial and not in agricultural districts. In the former it amounted in the case of infants to 600% in the course of 25 years. Here also there are additional differences, this mortality being higher in industrial neighborhoods having great generation of smoke (coal and Fe districts) than in such with less smoke (textile districts). Among the coal miners of the Ruhr district it is twice as high as among the inhabitants of an equal age of the entire Kingdom of Prussia; in England it is many times higher among colliers, coal heavers, chimney sweepers and soot dealers than among farm hands. T.b. spreads more rapidly in smoky districts. (2) The conclusions derived from statistics that smoke and soot cause a predisposition to acute pulmonary diseases and a more rapid course of t.b. are confirmed by the following pathological reports. Rabbits which inhaled moderate quantities of smoke or soot for several weeks had acute inflammation of the lungs on inhaling microorganisms, whereas the control animals remained healthy, and in the same manner t.b. had a quicker course in such animals than in those which had inhaled little or no smoke or soot. The inhalation of H_2SO_4, an important constituent of smoke, also accelerated the course of t.b. in rabbits. In the case of guinea pigs, which had become anthracotic by remaining in a large town, t.b. had a more rapid course than in the case of the control animals. (3) Smoke and soot favor the formation of fogs: these, again, concentrate the injurious constituents of smoke. Smoke robs towns of a much larger quantity of sunlight than was supposed hitherto. (4) The fight against coal smoke in civilized countries is one of the most important hygienic problems of the immediate future; in many districts, indeed, it is the most important. It will only be successful when it rests on a broad scientific basis, and when chemical, meteorological, technical and social conditions are taken into consideration in the same manner as

(continued on next page)

Ascher, L. (continued)
sanitary conditions. Technical progress, such as the invention of a cheap gas, may under certain circumstances solve the problem, e.g., land reform. (5) For the solution of such problems, in which all civilized countries are interested, an international course of action is to be recommended. (From Summaries of papers in Eng. News)

✓6. Jacobi, A.: Smoke in relation to health. J. Am. Med. Assoc. 49:813-5, 1907.
There was an increase in mortality due to bronchitis and pneumonia until 1891-1895, and a considerable decrease since, according to the 66th annual report of the Registrar General of England. L.W. Chubb, in conferences on smoke abatement, reports a decrease in smoke since that time. According to the medical officer of Manchester, the fog days and the mortality rate from acute pulmonary disease have become less. There is evidence of a higher mortality due to acute, inflammatory diseases of the respiratory organs both in towns and country in the regions of the Rhine and in Silesia, where much smoke is produced. This is mainly true for the coal mines of the Ruhr River district in Westphalia. Here, the mortality from inflammatory respiratory diseases among men is by 135% greater than among the Prussian men of the same age. Of those having died of these diseases, the majority had been born in that region, whereas the minority consisted of those who had come from distant rural districts. It appears statistically certain that smoke causes a predisposition to acute pulmonary diseases and accelerates the course of pulmonary t.b. It was also found that in humid atmosphere, coal dust was apirated in larger quantities than in dry weather. Bartel and Neuman (Wien. klin. Wochschr. 1906, Nos. 7 and 8; ref. from Heimann, H. et al.: U.S. Public Health Service, 1950) found that tubercular guinea pigs who had been exposed to a moderate amount of smoke died of pulmonary t.b. sooner than those which showed smoke-free lungs.

✓7. Niven, J.: The relation of smoke and health. Smoke Abatement League of Great Britain, Conf. Proc. 54, 1911.
The laws to control smoke and the progress made in its abatement are outlined. To measure the effect on health, the death rate for different years is used, although it is admitted that this is an imperfect criterion. Tables for annual death rates for Manchester for 1838-1910 show a decrease from 35.8/1,000 population to 25.24/1,000. The relative mortality from chest diseases for Manchester is compared with that for other towns, and a record of sunshine is also given. The death rates from pulmonary disease follow more closely the social circumstances than the atmospheric conditions of districts. Fogs do not allow the dispersal of SO_2. The increased rate of deaths from respiratory disease follows fog. The increase in mortality from bronchitis, like the increase from phthisis, follows more closely on the fog than does that from pneumonia. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

✓8. White, W.C. and Marcy, C.H.: A study of the influence of varying densities of city smoke on the mortality from pneumonia and tuberculosis. Trans. 15th Intern. Cong. Hyg. and Demog. 3:1020, 1913.
Statistics given for 1909-11 show the relationship of the t.b. and pneumonia death rates with smoke content of the air, with particular reference to Pittsburgh. A map of Pittsburgh is shown, dividing the city into wards, and the average density of the smoke is shown by various densities of shading. A graph depicts the pneumonia death rate and smoke content of the air by wards. Another plots similar information for the t.b. death rate and smoke content of the air by wards. The pneumonia death rate and smoke content of 15 cities of the United States are compared. The correlation of death rates from pneumonia and smoke content is

(continued on next page)

White, W.C., et al. (continued)
striking in Chicago, where the smoke content was comparatively low and yet the pneumonia death rate was very high. In the various cities smoke content was based on the distance of vision, using standard observation equipment, whereas in Pittsburgh carefully devised studies of precipitation of air content of C dust served as the criterion. The conclusion was reached that smoke is a very important factor in the unusual severity of pneumonia as encountered in Pittsburgh, and that some other factor must operate in those cities where the smoke content is comparatively low and the pneumonia death rate is still high. Also no correlation was found to exist between smoke content of the air and the t.b. death rate. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

✓ 9. White, W.C. and Shuey, P.: The influence of smoke on acute and chronic lung infections. Mellon Inst. Ind. Research, Smoke Investigation Bull. 9:164-73, 1914.

For this study, pneumonia was the criterion for an acute lung infection and t.b. for a chronic lung infection. In addition to smoke, other factors that may contribute to the drawing of any conclusions are discussed. In the various large cities in the United States where the study was undertaken, the number of years that the city had been incorporated and flatness of city contour were considered. Cities were plotted in decreasing order of smokiness for years 1908-12 against mortality due to pneumonia and t.b. Pneumonia showed a higher incidence in the smokier cities. On the other hand, mortality from t.b. increased as the number of smoky days decreased. No statistics were given to indicate whether the difference was significant. There were some exceptions to the above deductions in some cities. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

✓ 10. Holmes, J.A., Franklin, E.C. and Gould, R.A.: Report of the Selby Smelter Commission. U.S. Bur. Mines. Bull. 98, 1915, 528 pp.

An investigation in 1915 of the Selby smelter situation gave the following conclusions. Prior to Apr. 1, 1914, smoke, measured by the cumulative injury done to certain horses, was maintained in the "smoke zone." The installation of the bag house to the sintering machines of the smelter has abated this nuisance. Pb and As from the smoke was deposited on the soil of the "smoke zone" during the period of time included between the beginning of operations of the smelter and Apr. 1, 1914, but the quantity of these metals so deposited was of no economic importance and did not poison the soil or in any way produce a loss or reduction of crops. The blackened appearance of many trees and plants in the "smoke zone" thought to be due to a deposit of Pb from the smelter smoke, was not attributed to such cause. SO_2 from the Selby smelter had not produced within the "smoke zone" a disagreeable or objectionable odor, or disagreeably or injuriously affected the throat and lungs of human beings or domestic animals living in the "smoke zone." Rare occurrences of these disagreeable circumstances were not thought to constitute a nuisance nor to prevent the peaceful enjoyment of life and property. The smelter had not maintained a nuisance with respect to economic damage to trees, vines, shrubs or growing crops or to the corrosion of wire screens or barbed wire in use within the "smoke zone." The mechanical devices used at the Selby smelter (at the time of the report) for the control of smoke and SO_2 were thought to be adequate and if operated within specifications would not maintain a nuisance with respect to the above.

In the course of the investigation the following experiments on the effect of SO_2 on man were carried out. 60 subjects, in a total of 85 experiments, were exposed to various concentrations of SO_2 ranging from 1-12 ppm. 32 were previously acquainted with the odor of SO_2 and 28 were not. The "trained" subjects level of perception was 3-4 ppm, while that of the "untrained" was 4-5 ppm.

The last part of the report gives more details on the investigation.

11. Russell, W.T.: The influence of fog on mortality from respiratory diseases. Lancet I:335, 1924.

In a study of mortality from respiratory diseases for a 27-year period in 2 areas in Great Britain it was found that foggy days associated with low temperature showed the highest mortality from respiratory diseases. No increase in mortality rates from these diseases was noticed when fog existed with relatively high temperature. (It is to be observed that the term "fog" as used in this report is probably a combination of fog plus air pollutants of an industrial nature.) (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

12. Bundesen, H.N., Lemon, H.B., Falk, I.S. and Coade, E.N.: Ultraviolet radiation from sunlight and incandescent lamps. Its transmission through window glass and substitutes. J. Am. Med. Assoc. 89:187-9, 1927.

During this study on the penetration of UV light from sunlight through window glass it was observed that when Chicago's atmosphere is heavily laden with smoke, the solar spectrum usually does not show any appreciable light intensity below 3,100 Å, i.e., in the UV range. These observations were made by photographing the solar spectrum on a portrait film and calibrating the film. The period of observation was from Nov. 28, 1926 - May 16, 1927; the observations on smoke were made in Feb. and Apr., 1927.

13. Bloomfield, J.J. and Isbell, H.S.: The problem of automobile exhaust gas in streets and repair shops of large cities. Public Health Repts. (U.S.) 43:750-65, 1928.

In 14 large U.S. cities from Boston to San Francisco, having a combined population of 19,000,000, a survey was undertaken to determine the degree of health hazard, if any, due to CO from car exhausts. 250 air samples were taken and analyzed, 141 of them between 4:00 and 6:00 p.m. They were collected at breathing level of pedestrians at intersections with congested traffic, in tunnels for both cars and pedestrians, in taxicab stations, in buses and in houses opening on congested streets. A total of 102 air samples were taken in 2 car repair shops/city. All pertinent and modifying factors were recorded with the values obtained. Analyses by use of the I_2O_5 determination method, using a liquid air cooling tube, revealed the following CO contents (given in ppm): in the streets - average: 80, average ranges: 20-290. 24% of the samples taken in the streets showed >100, 1 contained 200. The values given for CO contents in the air of repair shops averaged 210, with average ranges of 10-1,100. 59% contained >100, 18% >400. 7 samples collected in buses contained an average of 50; the average ranges given are 10-100. The CO concentration on the first floor of several buildings is given as 40, while on the 4th floor, 30 were found. The CO contents of the air samples taken in the streets is not considered representing any health hazard. The potential hazard for the policemen could be diminished by reducing the time of exposure at intersections with congested traffic. The CO concentrations found in the repair shops, however, indicate a dangerous condition, and they also demonstrate that there is an even greater danger present in the small private garages. The motors of cars should not be run longer than 30 seconds unless the car is in motion or equipped with suitable exhaust outlets. At any rate, the discharge of exhaust gases into roofed enclosures should be avoided.

14. Meyers, J.: A study of cancer death-rate variations, combustion products of fuel, topography, and population. N.Y. State J. Med. 28:365-72, 1928.

The cancer death rates/100,000 for several countries in the world for 1900-09, and for various states in the U.S., for various cities in the U.S. and for various cities in N.Y. State in 1920 are given. Though there was a marked and interesting variation in cancer death rates, no particular trend was noted. The results of C.E. Green's investigation on cancer in Scotland and England are discussed. Variations in cancer death rates are attributed to topographical considerations, excessive presence of SO_2 gas from the use of coal with high S content and uneven roof lines causing poor house or chimney ventilation. Similar reports in the literature are reviewed.

A cancer survey of the Borough of Richmond or Staten Island was begun in Nov. 1920 and covered the 7 years from 1914-20 inclusive, when the population was very stable. The borough was chosen because it has a varied topography, and its northern shore is greatly polluted by smoke, fumes and vapors from great oil refineries, and chemical, metal and other works situated in N.J. across the Kill van Kull, while the rest of its shores is much less polluted. The island was divided into 13 districts according to topography and the amount of pollution. The survey revealed that 515 deaths at all ages occurred from malignant diseases during the period of the survey and that the cancer death rates/100,000 in the various districts ranged from 42.1-78.9. These were corrected weighted average annual cancer death rates. The following conclusions were drawn from the study: On Staten Island, individual or parent nativity does not alter the corrected death rates. In mixed populations, differences in cancer death rates among Irish, German, English and Italian and native tend to neutralize each other. Diet also was found to be of no great moment. There may be an etiological relation between the incidence of cancer and topography, open level districts, of high or low altitude, showing lower cancer rates than land in hollows or depressions or intersected by gullies, valleys or lying against adjacent hills. Albany and San Francisco should make interesting studies. There may be an etiological relation between the combustion products of coal and oil and cancer. Those sections of Staten Island exposed to smoke fumes and gases show a higher cancer death rate than those not so exposed. House heating and chimney ventilation are also important, as gases and fumes from these sources may bear a relation to cancer incidence as found in the districts. The better combustion of fuels in industry and homes, or the absorption of gases, smoke and fumes to avoid atmospheric or room contamination, may mean less cancer. Whatever may be the possible errors in this study of a comparatively small number of cases (515), it cannot fail to show even on an island 13 1/2 x 7 3/4 miles, divided into 13 districts, variations in cancer death rates, and these variations would seem in the light of the findings to bear a relation to etiological factors of fuel and topography. These conditions therefore would seem to be a part of the complex etiology of cancer.

15. Osborne, H.M.: Atmospheric pollution. Med. Officer 39:63-5, 1928.

The remarkable reduction in enteric diseases is considered a mark of success in efforts at improved sanitation. The high rate of respiratory diseases from the years 1921 to 1925 are given for various British communities. Areas in which deaths from bronchitis are more than 50% greater than that of England and Wales as a whole are indicated. Among the highest were Manchester and Salford, which are noted for their heavy smoke pollution, dampness, rawness and relative absence of sunshine. Domestic tarry smoke is indicated as the chief offender. Local doctors commonly find their bronchitis patients dying off in numbers during prolonged periods of winter fogs. In the report of 1923 charts were produced showing a close

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Osborne, H.M. (continued)
relationship between periods of winter fog and deaths from respiratory disease. There is little doubt that a smoke-polluted atmosphere is responsible for much of the nasal and bronchial catarrh that is prevalent. An indirect but serious effect of smoke is loss of sunshine. Such loss leads to increased incidence of rickets, anemia and t.b. and to interference with normal growth. In 1926 the general death rate was the lowest ever recorded at Salford, and the biggest reduction was in deaths due to respiratory diseases. This fact is correlated with the prolonged coal strike and the consequent, relatively pure atmosphere for that year. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

16. Shrader, J.H., Coblentz, M.H. and Korff, F.A.: Effect of atmospheric pollution upon incidence of solar ultra violet light. Am. J. Public Health 19:717-24, 1929.
The distribution of dust in the atmosphere over Baltimore was determined by placing catch-cups at street level in 3 groups: 1 in the center of Baltimore, 5 in an arc ca. 3 miles from the center, i.e., in the suburbs, and 3 in an arc ca. 10 miles out in the country away from highways. Konimeter measurements of the dust collected from Apr.'27-Apr.'28 indicated that atmospheric pollution was heaviest in the center of the city, i.e., 1800 tons/sq.mi./yr., and fell off to approximately 1/6 as much in the country, i.e., 340 tons/sq.mi./yr.; it was ca. 800 tons in the suburbs. Contrariwise, the amount of solar UV light, measured by the lithopone method and checked by 3 other chemical methods, was 50% greater in the country than in the city. Further, it was found that the amount of settled dust on the top of a tall city building (231 ft. high) was materially less (4,566 tons/sq.mi./yr.) than at street level (5,359 tons/sq.mi./yr.), while the incidence of solar UV light on the building was greater (ca. 0.43) than at street level (ca. 0.31), a ratio of 1:0.7. Measurements made on "clear" days showed somewhat greater incidence of UV light than on cloudy days. The greatest pollution from all sources was found to occur in the spring and summer seasons of that period. The passage of UV light through air confined in a box artificially polluted with fuller's earth, street sweepings and lamp black, respectively, shows that they are increasingly effective in the order mentioned in occluding solar UV light. For 5 g. dust/2.25 ft.^{3} , the % transmission of UV light was 60, 54 and 14%, respectively. Therefore, C as tarry products is materially more inhibitive to the incidence of UV light than siliceous materials. Measurements to determine the sky radiation in the city showed that skyshine yields ca. 70% of the amount of UV light received by direct sunlight.

17. Tonney, F.O., Hoeft, G.L. and Somers, P.P.: Loss of actinic intensity in urban sunshine due to air pollution. J. Prev. Med. 4:139-48, 1930.
Observations of the loss of solar UV light values in Chicago, due to atmospheric pollution were made over a period of ca. 3 years, since it is shown that solar actinic intensity as correlated with the erythema dose may be used as a practical criterion of the health value of sunshine from the standpoint of its antirachitic and related effects. Simultaneous hourly readings on days selected for uniform weather conditions were made at 2 clear points outside the city and at 6 stations within the city, including the loop, S, W and N sections. The hourly actinic intensity, as measured by the mg. oxalic acid decomposed, and as % of climatic maximum, is plotted for various stations during various months. Material loss of the UV intensity available at the clear points was demonstrated in all the urban districts tested, at all seasons of the year. The % loss was greatest in the warm months (ca. 50%) when the

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Tonney, F.O., et al.(continued)
concentration of the shorter UV waves is greatest. The least % loss and the lowest absolute intensities were observed in the cold months (ca. 43%), when only the longer rays of the UV spectral region are present in significant amounts. The lake shore districts of the city, viz., loop and N side, showed relatively less loss of UV light than the stations farther inland, viz., S and W sides. The high % loss of short UV waves in summer, the season of minimum smoke production, suggests that the improvement to be expected from smoke abatement methods applicable to existing combustion processes will not in reality solve the problem, and seems to justify the view that the general substitution of electric energy for combustion processes as a source of heat, light and power is the logical ultimate solution.

✓ 18. Firket, J., Secretary: Sur les causes des accidents survenus dans la vallee de la Meuse, lors des brouillards de décembre 1930. Résultats de l'expertise judiciaire faite par M.M. Dehalu, Schoofs, Mage, Batta, Bovy et Firket. (The causes of the symptoms found in the Meuse Valley during the fogs of December, 1930. Results of the Judicial Investigation made by Messrs. Dehalu, Schoofs, Mage, Batta, Bovy and Firket.) Bull. acad. roy. med. Belg. 11:683-741, 1931.

A thick fog which covered the Meuse Valley from Huy to Liege, Belgium caused a large number of persons to be ill, several hundred of these very severely ill, and 60 persons to die, and many cattle to be killed.

Statement of the medical findings

Examinations of the ill on Dec. 6 - 7, 1930 revealed that all had symptoms of retrosternal pain, cough and dyspnea either polypneic or more frequently asthmatic. A large number of patients also showed signs of laryngeal irritation, attacks of nausea and vomiting, lacrimation, especially in Engis, and other signs of local irritation of the upper respiratory tract.

Outside of these symptoms of local irritation of the upper and lower respiratory tract, there were scarcely any clinical indications of the action of a noxious agent beyond the mucous membranes.

The persons particularly affected were old persons, asthmatics, cardiacs and asthenics. The fatalities occurred mostly at Seraing (12), Yvoz-Ramet (7), Jemeppe (9), Flemalle (14), Engis (14) and Amay (4). Upstream from these centers, toward Huy, the number of patients was still large but no fatalities occurred. Exact data were not obtained, but it was estimated that several thousand had taken ill.

The 1st symptoms appeared about midday, Wed., Dec. 3, reaching a high incidence that night and the next day, Dec. 4. Fog was densest these 2 days. Symptoms improved rapidly on Dec. 5. Fatal cases occurred on the 4th and 5th of Dec.

10 autopsies made on Dec. 7-11 showed varying degrees of congestion of the tracheal mucosa and of the large bronchi, with desquamation of the superficial epithelium and dilatation of the dermic vessels. No clearly limited zones of necrosis were observed. Fine black granulations (negative test for Fe) were present in the pulmonary alveoli, which were either free or within the polynuclear leucocytes, indicating they had been inhaled recently. No recent structural alterations of the viscera could be found as is common in intoxications.

Blood spectroscopic analyses showed no free SO_2, the normal $SO_4^=$ content, no F^- and no CO. Analyses of the viscera for metal showed traces of As in non-toxic amounts and similarly Zn in some cases, and the normal $SO_4^=$ content. Analyses of the lungs showed fine dusts, 0.5-1.35 μ in diameter, consisting of pure C which had been recently inhaled according to histologic evidence.

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Firket, J., Secretary (continued)

An examination of the cattle was also made. The onset of symptoms occurred on the night of Dec. 3/4 and on the day of the 4th. Most of the animals in the valley suffered symptoms of quickened and more superficial respirations, rapidly progressive dyspnea, cyanotic appearance of the mucous membranes and localized pulmonary emphysema frequently complicated by subcutaneous emphysema. The asphyxia increased and the animals died. The digestive tract was also affected. The results of the autopsies of animals were similar to those on humans. The symptoms of the cattle ceased when they were removed to the hills.

It is concluded that all the clinical symptoms are indications of either a relatively superficial local action of an irritant, or of a reflex released by this local irritant. They are not indications of a true toxin.

Meteorological conditions during the fog

The meteorological situation from Mon., Dec. 1 - Fri., Dec. 5 in Belgium was anticyclonic characterized by high atmospheric pressures and mild easterly winds. Cooling of the air with temperature inversion occurred and caused formation and persistence of fog. The condition favored the mixing of noxious gases and impurities of all kinds from the fumes of industrial and other chimneys in a limited volume of air. Within 2-3 days extremely minute solid and liquid particles, 1-5 μ in size, were noted in the air and on the ground. They moved with a very low velocity, which made them more easily respirable by persons and animals.

Results of chemical analyses

At the industrial plants no manufacturing accident was discovered that could have caused abnormal or exceptional toxic emanations during the period of the fog.

Chemical analyses of raw materials, intermediates, gases and fumes were made at all the plants and from this was obtained a list of all the substances possibly released into the atmosphere between Liège and Huy: H_2, SO_2, $SO_3(H_2SO_4)$, HCl, H_2F_2 and its salts (NH_4F, ZnF_2), CO, CO_2, H_2S, NO, NO_2, HNO_2, HNO_3, NH_3 and its salts, $(NH_4)_2S$, CH_4, C_2H_6, unsaturated hydrocarbons, gasoline vapors, odor of organic products of PO_4^{-3} plants, drops of tar, phenol, naphthalene, etc., soot, cement dust, lime dust, metal dust, ZnO, Pb, As_2O_3, AsH_3, CH_3OH, C_2H_5OH, HCHO, $ZnCl_2$ and silica from Bessemer steel works, and any possible products from chemical or physical interaction, e.g., solution and absorption.

These substances were released from 4 very large steel plants, 3 large metallurgical works, 4 electric power generating plants, 6 glass works, ceramic plants and brick works, 3 groups of lime kilns, 3 Zn plants, 1 coking plant (coal mine), 1 gunpowder factory, 1 H_2SO_4 plant and 1 concentrated fertilizer plant.

The results of the analyses of the fumes for CO_2, CO, N_2, SO_2, F_2, SO_3, NO_2 and, in some cases, dust from both homes and plants in the various towns/24 hours are tabulated (1st appendix). However, emanations from the plants in Liège and Huy or from trains or automobiles of the entire region are not reported, and the description of the methods of sampling and of analysis are not given. The evaluation of domestic fumes was considered low (based on 15 kgs. of coal containing 1% volatile S burned daily).

Interpretation of the results obtained

The chemical substances were examined with respect to their ability to produce the observed symptoms and the following was concluded: There was no insufficiency of O_2 in the fog-laden atmosphere, since calculations showed that the decrease of O_2 content was not even 10% while a decrease of 15% is required to produce ill effects. (continued on next page)

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CO_2 does not produce the observed symptoms, nor was its concentration of 1 1/2% high enough to produce any ill effects; >2% is required. CO also does not produce the observed symptoms or necropsy findings, nor was it found in the blood, and calculations indicated it to be present in insufficient quantity to be toxic. H_2, H_2S and AsH_3 do not exercise any local action.

The alkaline F^-'s and fluosilicic acid could produce such irritation, but they were produced only locally.

It had been observed that noxious substances in the solid state or in the state of liquid droplets that are slightly soluble/H_2O, produced limited lesions in the upper respiratory tract which were different from those found in the autopsies. However, very fine particles, such as were present in the dusts in the valley, though inoffensive in the pure state, absorb readily and may have transported relatively large concentrations of noxious gases and liquids into the lungs.

Acetylene and hydrocarbons do not cause local irritation, and particles of tar, phenol, naphthalene, etc., do not cause the observed lesions.

The entire series of combination products of the acid and basic dusts do not act in the observed caustic manner, nor were they distributed throughout the valley in sufficient concentration to be considered.

The low temperature and density of the fog themselves would not cause the observed symptomatology, but rather infectious symptoms, which were not present.

H_2F_2 was given off from only 1 plant. The accumulated concentration of 4 days (0.4 mg./m.^{3}) spread homogeneously throughout the valley was highly improbable and, further, was not considered harmful, though no LD value had been reported in the literature. However, it could well have been an important irritant around this local area where its concentration was far above the noxious level.

Though the vapors of NO, NO_2, NH_3, HCl cause the observed irritant action, the chemical analyses showed their concentrations to be below the toxic level except, perhaps, around the furnaces that gave them off.

Though homogeneous distribution was generally assumed, this was not valid since there was a concentration of noxious substances in the Engis-Seraing region as evidenced by the greater number of fatalities. This is explained by the predominant easterly direction of the wind during the fog which carried the pollutants to the northern declivity of the valley where the abrupt hills and atmospheric ceiling caused them to be concentrated. Such topographical considerations of the zones of concentration explain the irregular distribution of serious symptoms in the valley.

The chemical analyses showed that the S derivatives (SO_2, SO_3, H_2SO_3 and H_2SO_4) and especially SO_2 were the most abundant irritant gases emitted into the valley. $SO_2 + H_2O = H_2SO_3$ readily takes place in fog where the H_2O is in the liquid state. $H_2SO_3 + (O) = H_2SO_4$ takes place more readily than $SO_3 + H_2O = H_2SO_4$. Ideal conditions were present for the former since the dispersed liquid state of the reactants (O_2/H_2O), plus the mild wind movement and atmospheric stability in fog, provided good contact and various oxidation catalysts for the reaction (i.e., finely divided Fe_2O_3, ZnO and other oxides) were also present in the air. In dry weather, the 1st 3 conditions are not present and the conversions $SO_2 \rightarrow H_2SO_3 \rightarrow H_2SO_4$ are greatly hindered.

Further, it is observed that exposures for prolonged periods of time to low concentrations of SO_2 cause serious symptoms while short exposures to high concentrations of SO_2 produce only fleeting symptoms.

Since SO_2 was emitted throughout the Meuse Valley, it would account for the simultaneous appearance of symptoms throughout the valley. Again, fatal cases occurred in those areas of greater SO_2 concentration from industrial emission and from city fumes swept in by the wind. To produce the toxic concentration level of H_2SO_4 throughout the valley, only 5.2 tons of

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SO_2 would have been needed. It was estimated that 240 tons of SO_2 were liberated for the 4 days.

It is concluded that since finely divided drops of H_2SO_4 irritate the upper respiratory tract and SO_2 penetrates and irritates the depths of the respiratory tract, these 2 substances account very well for the observed physiopathological symptoms. No positive evidence, e.g., chemical analysis of the fog, was obtainable, but no other irritant agreed with the medical, toxicological, meteorological and chemical findings as well. Though less serious symptoms had been observed in previous fogs, the industrial centers have grown with consequent greater emission of pollutants. A condensed report of this investigation in English appeared as: Firket, J.: Fog along the Meuse Valley. Trans. Faraday Soc. 32:1192-7, 1936.

19. Tonney, F.O. and DeYoung, C.R.: Smoke eradication to save the health value of urban sunshine. Am. J. Public Health 21:344-54, 1931.

Included in this discussion on the inadequacy of the smoke control measures at that time and of the suggested remedies by central steam heating, gas heating and electric heating are charts showing the relation of total deaths/month and deaths from acute respiratory disease/month during 1926-27 in Chicago. A remarkable correlation between respiratory disease deaths and erythema hours/month is demonstrated. Low erythema hours are observed to be followed by high respiratory death rates with a "lag" of 1-2 months and conversely the higher erythema hours/month are followed by correspondingly lower respiratory death rates, after a similar "lag".

20. Mage, J. and Batta, G.: Resultats de l'expertise judiciaire sur la cause des accidents survenus dans la vallée de la Meuse, pendant les brouillards de decembre 1930. (Results of the judicial investigation on the cause of accidents which occurred in the Meuse Valley during the fogs of December, 1930.) Chimie et Industrie 27:961-75, 1932.

In substance, this report repeats in a more concentrated form the information published by the Secretary of the Board of Experts, J. Firket, in Bull. acad. royale de med. de Belgique 11:683-741, 1931. Nothing new is presented concerning the following points: 1) the metereological conditions in the Meuse Valley at the time of the fogs, 2) the medical findings, including the autopsy reports, 3) the results of the industrial chemistry analyses, including a description of the industrial plants, their location in the valley and of the composition of the waste gases as they were given off at the time of the incidence, and 4) an interpretation of the investigation results, leading to the conclusion that under the same meteorological conditions and at the same rate of industrial production, a similar situation might happen again. As to the geography of the valley, it is described as being 30 km.long, less than 1 km.wide - near Engis only 800 m.- and extending from NE to SW, from Liege to Amay. The surrounding hills are 75-100m.high. Most of the industry is concentrated between Ougree-Tilleur and Engis.

The following table gives the maximum concentrations of the toxic waste gases as they could prevail in the Meuse Valley (calculated for the region between Ougree and Huy, extending over 25 km.) provided the same meteorological and industrial conditions were again present. The values for 1 and 4 days after the incident are given, as well as those concentrations of the gases which are considered to have a toxic effect after several hours' exposure.

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gases	toxic concentrations after several hours' exposure	Maximum concentrations after 1 day	after 4 days
CO_2	> 2% vol.	about 0.4% vol.	about 1 1/2% vol.
CO	>1/2%	" 0.09% vol.	" 1 1/3% vol.
NO_2	0.12-0.16 g/m.^{3} air	1 - 2 mg./m.^{3}	4 - 8 mg./m.^{3}
HF	not established, about 4 mg./m.^{3} air	0.08 mg./m.^{3}	0.3 mg./m.^{3}
SO_2	20-30 mg./m.^{3} air	25 mg./m.^{3}	100 mg./m.^{3}
H_2SO_4	4 mg./m.^{3} air	38 mg./m.^{3} provided there is complete oxidation of SO_2	152 mg./m.^{3}

At the end of the publication, the authors refer to a report - which they intend to publish shortly - on laboratory experiments dealing with the oxidation of SO_2 in fog.

21. Seczyk, K.: (Results of research on air pollution by sulfur dioxide in region of zinc industries in Silesia.) Medycyna Doswiadczalna i Spoleczna, 15: 296-326, 1932.

Gases emanating from Zn and Pb foundries in the district of Katowice have been detrimental to the small nearby farms. These foundry gases are composed of particles of ore, coal dust, Pb, Zn, SO_2, CO_2, CO and possibly H_2S and AsH_3. Because there is a limited demand for H_2SO_4, SO_2 is discharged into the air. Toxic effects of SO_2 on man are described. Low concentrations cause "coughing and symptoms of scratchy mucous membranes of the respiratory passages. High concentrations damage mucous membranes and cause catarrh of bronchi, possibly hemorrhage, and finally inflammation of the lungs." There is apparently no effect on the blood. A permanent worker is not affected in a SO_2 atmosphere, whereas a new man may feel ill. Study was undertaken "to determine how SO_2 is diluted in the atmosphere, and at what radius from the center of production it settled and can act injuriously on people." The manner of carrying out research is described. It was found that wind of uniform velocity (2 m./sec.) does not appreciably dilute the SO_2. Data are given for many sampling points: Distance from the source of SO_2, concentration of SO_2, temperature, humidity, wind direction and concentration of SO_2 found at that point. Rain never favored the disposal of the gases because the concentration was higher in rain than during good weather. The levels of SO_2 obtained for Silesia were more damaging than those for Pittsburgh. In fine weather, the SO_2 content for the locality immediately about these foundries was lower than when there was a heavy fog, a low overcast or rain. Wind played an important role in distributing the gases. Weak winds and calms appeared to disperse the gases much better than strong winds. SO_3, H_2S and H_2F_2 were found in the chimney gases but not in toxic amounts. (Abst. Heimann, H., et al,: U.S. Public Health Service, 1950.)

22. Bloomfield, J.J. and Isbell, H.S.: The presence of lead dust and fumes in the air of streets, automobile repair shops, and industrial establishments of large cities. J. Ind. Hyg. 15:144-9, 1933.

In 14 of the largest U.S. cities, 78 air samples ranging from 4.4 to 14.2 m.^{3} and averaging 7.8 m.^{3} were collected and analyzed for the amount of Pb dust or Pb fumes present. The samples were taken at the following

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locations: a) 25 - in car repair shops not handling tetraethyl lead gasoline, b) 28 - at heavy traffic intersections and c) 25 - in a great variety of non-Pb-using industrial establishments. Controls were provided for each of the series of samples. An impinger was used for collecting the samples, distilled H_2O being the collecting medium, and the modified Fairhall method was employed for analysis. All potentially influencing factors were recorded. The results are given in mg. Pb/10 m.^{3} of air. As regards c), they ranged from 0.35 in the sewing room of an underwear factory to nil in 6 different plants, the average being 0.10. The Pb values of the other samples averaged: for a) - 0.13, for b) - 0.09, the respective maxima being reported as 0.34 and 1.11 respectively, while all minimum values indicated the absence of Pb. There was no relationship between the modifying factors recorded and the amounts of Pb present. A comparison of the values obtained from the samples collected at all 3 location types shows that 86 % contained <0.2 mg. Pb/10 m.^{3} of air, and that none of the values obtained from analysis of b) and c) samples exceeded 0.4 mg. Pb/10 m.^{3}. Only 2 samples taken in a) contained >0.4 mg. /10 m.^{3}.

The study demonstrated that there are amounts of Pb normally present in the atmosphere of locations such as the ones investigated, even though negligible. This fact accounts for the presence of Pb in the excreta of persons who have no industrial exposure to Pb.

✓ 23. Dunn, J.T. and Bloxam, H.C.L.: The occurrence of lead, copper, zinc, and arsenic compounds in atmospheric dusts, and the sources of these impurities. J. Soc. Chem. Ind. 52:189T-92T, 1933.

Samples from both the distillation and combustion of coals from different sources and from mixed coals were analyzed for Pb, Cu and Zn. All but 1 of the 25 samples contained Pb ranging from 0.06-1125 ppm; 20 contained Cu from 2.5-650 ppm; and 7 contained Zn from 12-12,050 ppm. It is concluded, therefore, that these metal compounds would be present in atmospheric dusts, domestic dusts and in dusts of any kind deposited in the neighborhood of towns or works in which coal was burned. Examination of dusts removed from the shelves of occupied business offices, porticos of houses and the entrances to public buildings showed 17-3000 ppm Pb, 300-1600 ppm Cu, 0-12,000 ppm Zn and 50-400 ppm As. Though an attempt was made to obtain information about the deposition of these metallic compounds at different seasons of the year, this was found impracticable as the amount of dust and soot varied enormously even during the same months in successive years. Analysis of grasses near the leeward sides of roads in constant use by motor traffic invariably showed small quantities of Pb (5.5-7 ppm) and Cu (0.4-7 ppm), but no Zn. However, on the windward sides of the roads no Pb was found. The Pb so found is attributed to the addition of TEL to some gasolines. "Dusts containing such toxic substances as compounds of As, Pb, Cu and Zn, if not actually poisonous, may be expected to be injurious to health." Analyses of the organs of sheep and cattle, who had fed on herbage on which dust was found, showed the presence of these poisonous substances. Fowl exposed to dusts on the floor of the fowl house became ill, but recovered upon removal of the dust. Pb was found in very small amounts (exact amounts not stated) in the organs of a 5-year old child who died unaccountably. Since she had lived a very protected life and was under careful supervision, it is surmised that the Pb found in her body could only have been air-derived. These metallic compounds may also assist in the corrosion of galvanized surfaces, and of other unprotected metals.

24. Gage, S. DeM.: Aerial nuisances from the refining and burning of petroleum oils.. Am.. J. Public Health 23:97-104, 1933.

Odors can affect public health not only by directly causing diseases but also by being offensive - the degree depending on the sense of smell and the susceptibility of the exposed persons - and thus indirectly produce systemic disturbances. There is no sharp line between psychological and physiological effects. The importance of air pollution abatement is stressed by recalling the Mills-Reinke effect, i.e., the mortality from all diseases decreasing following water purification. In 1920, due to complaints about an odor nuisance in the Providence, R.I. area (23 sq. mi., population 126,000), the State Board of Health of R.I. conducted an investigation to determine the origin, magnitude and effect, if any, of the odors. The odor was found to originate from at least 4 large oil burning power plants and also from oil burning installations for heating commercial and private buildings. Offensive odor was recorded on 112 out of 158 days in 1 of the 3 affected districts and on 75 out of 121 days and 57 out of 148 days in the other 2. For the effects on the general health, a representative group of 300 of the 1,000-1,200 people affected was interviewed by a qualified physician experienced in industrial hygiene and a questionnaire was sent to all practicing physicians (ca. 725) in the state which requested information on all those who had been made ill by the odors. The following primary symptoms were reported by 96 people: nausea (56 persons), headache (44), irritation of throat (42), suffocation (27), malaise (25), dizziness (22), choking sensation (13), irritation of nose (5), irritation of eyes (2) and gastric trouble (2). Secondary symptoms noted were pulmonary t.b., asthma, pharyngitis, laryngitis, as well as cardiac and nervous disorders. 77 persons gave $\geqq 2$ symptoms, 46 - $\geqq 3$ symptoms, 14 - $\geqq 4$ symptoms. Between 120-150 physicians of the 190 who replied to the questionnaire thought that the air was polluted by the volatile constituents of petroleum, sulfides or SO_2 and would certainly adversely affect the health of nervous and respiratory patients. It is concluded by the author that the refineries handling high S oils give off large quantities of sulfides and CS_2 which are highly poisonous and produce symptomatic disturbances when diluted with considerable volumes of air, and also S oxides which affect the respiratory and digestive systems and CO from incomplete combustion.

25. Ives, J.E.: Loss of light due to smoke in Baltimore, Md., from October, 1929, to September, 1930. Public Health Repts. (U.S.) 48:113-25, 1933.

Records of the total horizontal illumination were obtained by means of a photoelectric cell and a recording potentiometer from October 1, 1929, to September 30, 1930, at the Central Police Building, Baltimore, Md., where the air was smoky, and at the State sanitarium at Mount Wilson, about 10.5 miles to the NW of Baltimore, where the air was comparatively free from smoke. From these records the average hourly illumination on a horizontal plane for each month of the year, the average hourly illumination for the whole year, and the daily average for each month have been calculated for each place. The absolute and relative losses of light from smoke at the Central Police Building have been determined from the records. The highest average daily horizontal illumination at Mount Wilson occurred in July and the lowest in December. The greatest total loss of light due to smoke at the Central Police Building was also in July and the least in December. The records showed a large relative loss of light due to smoke. In some cases the average hourly or daily loss was greater than 50%. The average loss for the whole year was 13.2% for clear days, 15.9 for cloudy days and 14.1 for all days. The average % loss of light for the whole year was therefore greater on cloudy days than on clear days. The % loss of light for clear days at the Central Police Building in Baltimore varied with the time of the day, being greater in the morning and in the late afternoon than at 2:30 p.m.; the average loss

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Ives, J.E. (continued)
of light for the whole year for the hours ending at 8 a.m., 3 p.m. and 5 p.m. was 15.5, 10.8 and 14.8, respectively. For cloudy days the % loss of light was found to be less in the morning and in the late afternoon than at 1:30 p.m.; for the hours ending at 9 a.m., 2 p.m. and 4 p.m. it was 13.6, 21.5 and 11.5%, respectively. The analysis of the results showed that the % loss of light depended, among other things, upon the nature of the sky, whether clear or cloudy, upon the relative humidity of the air and upon the velocity and direction of the wind. For the same relative humidity the average % loss of light, both for the whole day and for the noon hours only, was found to be less for a cloudy than for a clear sky. In the New York study, the reverse was found to be true. For the same kind of sky, clear or cloudy, and for the whole day, or for the noon hours only, the average % loss of light increased with increase of relative humidity, the % loss of light being about twice as great for 70% relative humidity as for 30% for clear days and clear noon hours, and about twice as great for 90% relative humidity as for 50% for cloudy days and cloudy noon hours. Other conditions being the same, the % loss of light for clear days was found to decrease as the velocity of the wind increased, being roughly inversely proportional to the velocity of the wind. No definite relation between the % loss of light and the average velocity of the wind was found for cloudy days. For clear days the % loss of light was found to be greatest for southerly winds, and least for northwesterly. For cloudy days the % loss was greatest for SW and S winds, and least for NW ones.

26. Brown, E.G., Gottlieb, S. and Laybourn, R.L.: Dust storms and their possible effect on health. With special reference to the dust storms in Kansas in 1935. Public Health Repts. (U.S.) 50:1369-83, 1935.

The dust storms that occurred in the central west from Feb. through Apr., 1935, affecting particularly the western part of Kansas, were the result of several phenomena, e.g., a decrease in rainfall during the preceding 4 years, a lack of growth of vegetation and the occurrence of high winds. Great damage was done to homes, crops, e.g., to wheat, barley and oats, and also to lifestock, the latter due to the dust covering the pastures. Innumerable jack rabbits and birds were killed. Drift covering the fields, roads, highways and the farm machinery often was several feet high. It is stated that, in spite of the enormous shifting of the soil, the actual damage to the farm land was small. Tabulated data on days with especially severe dust storms show considerable rises in temperature, accompanied by remarkable drops in humidity during the course of each day. Determinations of the bacterial contents of the dust demonstrated that it did not carry pathogenic organisms. The dust samples were also subjected to chemical analysis which showed them to consist mainly of SiO_2; the ranges in 6 samples are given as 66.9 - 92.9%. In addition, metal oxides were detected at amounts ranging from 5.2 - 15.4%, and CaO at 0.2 - 1.6%. The measurement of the dust particle size in the 6 samples shows the following ranges: maximum, 70-770 μ; minimum, 2-120 μ, averages, 26-330 μ. The dust drifting from the Middle West to Boston averaged 20 μ in particle size. The predominant physiologic action of the dust was manifested in irritations of the respiratory mucosae. A marked increase was reported in death rates due to respiratory infections, especially pneumonia, and infant mortality, further in the incidence of measles, corneal ulcers and eye infections. Among the control measures recommended by the author, dustproofing of the homes and the wearing of masks are the most important.

It is stated that prolonged or repeated exposure to such dusts might result in similar effects as have been observed due to exposures in mining or other industries.

27. Ritchie, A.W. and Langrishe, J.: Smoke abatement. J. Soc. Chem. Ind. 54: 979-82, 1935.

Mr. Allen, Chief Sanitary Inspector, Edinburgh, discussed the causes of smoke, the measures taken for the reduction of smoke and the investigation into atmospheric pollution. The data from the deposit gauges at 3 places in the city are given for 1929-34. The values ranged from 13.67-16.67 at Leith Links, 12.80-15.09 at Bruntsfield House and 19.78-27.51 tons/sq. mi./mo. at Princes St. Gardens. The Owens automatic air filter showed that pollution is at a minimum at 3 a.m., increases to a maximum at 9-10 a.m., decreases again 'til 3 p.m. and then reaches a secondary maximum at 7 p.m. Pollution is about 31% less in summer than in winter. A comparison of the results obtained on weekdays and Sundays indicate that 4/5 of the pollution in the City is domestic and 1/5 industry. December has the highest pollution and July the lowest. Measurements of S pollution by bubbling the air through H_2O_2 solution and subsequent titration showed <0.1 ppm SO_2 in Nov. and Dec.

Lt. Col. Langrishe reported that from the statistical evidence the number of deaths from pulmonary and heart diseases increases in direct proportion to the intensity and duration of smoke-fogs. As cited by Baillie Brownhill Smith, in Nov. and Dec. 1909, Glasgow had 3 periods of dense smoke-fog. Deaths from respiratory diseases during the week preceding the fog totalled 75; during the week of the 1st fog period they amounted to 138 and in the ensuing week they rose to 233. Over the whole period of bad fogs the respiratory death rate rose from 2.1-13.9/1000, while in 7 other towns, fog-free at this time, the rates rose from 1.6-4.8/1000. This difference in Glasgow had accounted for 1000 actual deaths. The effects of obstruction of sunlight are distinct. Manchester on a still day receives 55% of the daylight received in Timperley, only 6 miles S, and on foggy days it receives but 5%. Even less UV light with its less penetrating powers is received. The loss of visibility is also hazardous. A 25% increase in industrial accidents is estimated to be caused by reduction of visibility indoors, and the compensatory use of artificial lighting is estimated to cut output by 11%. The stunting effect of loss of solar radiation on human beings, the psychological ill-effects and the action of smoke on vegetation are mentioned.

28. Schnurer, L., Allison, W.C., Boucek, C.M. and Haythorn, S.R.: Pneumoconiosis in the Pittsburgh District, based on a study of 2500 post mortem examinations made in Pittsburgh hospitals. J. Ind. Hyg. Toxicol. 17:294-7, 1935.

It had been noted that the death rate from t.b. was much lower in Pittsburgh than in the U.S. as a whole, while that from pneumonia was much higher. Therefore, a study of the protocols, histories and sections of 2,500 post mortem examinations was made in Pittsburgh to discover if possible what dust diseases were common in Pittsburgh, whether SiO_2 was present in an injurious amount, and to ascertain the relationships of dust deposits and t.b., pneumonia and other pulmonary affections. and heart disease. The age peak at which anthracosis occurred increased with the degree of anthracosis found. The author considers that though it is not yet proved whether or not SiO_2 was present in the deposits in the lungs, it is known that these deposits tend to aid in the healing and walling off of tuberculous foci rather than tending to cause t.b. For of 113 autopsies of soft coal miners only 4 cases of active t.b. were found, and there were 39 in which completely healed and encapsulated lesions occurred. Practically no relationship between pneumonia and heavily pigmented lungs could be demonstrated though 1,180 cases of pneumonia were found. The study also showed him conclusively that any grade of anthracosis may develop entirely independently of heart disease.

29. Coste, J.H. and Courtier, G.B.: Sulfuric acid as a disperse phase in town air. Trans. Faraday Soc. 32:1198-1202, 1936.

A method of investigating the H_2SO_4 content of the air which does not involve the use of filters is described. The amounts of H_2SO_4 in central London were estimated to vary between 1 and 20 x 10^{-6} g./1000 l.; the SO_2 in the same samples of air varied between 0.10 and 0.50 ml. (equivalent to 440 and 2200 x 10^{-6} g. H_2SO_4). The maximum amounts of H_2SO_4 were usually registered in periods of calm and in foggy conditions, while the amounts were invariably small after rain. No exact relationship was established but, in general, conditions which favored high SO_2 content also favored high H_2SO_4 content. There was some evidence that the proportion of H_2SO_4 was greater at ground level than at 6th floor level. Some observations made at an outlying northerly suburb showed that while the SO_2 content was only 0.02 ml./1000 l. (equivalent to 44 x 10^{-6} g. H_2SO_4) the amount of actual H_2SO_4 was 4 x 10^{-6} g.

30. Ives, J.E.: Studies in Illumination. III. A Study of the Loss of Light Due to Smoke on Manhattan Island, New York City, During the Year 1927, Especially in Its Relation to the Nature of the Weather, the Relative Humidity of the Air, and the Velocity and Direction of the Wind. U.S. Public Health Service Bull. No. 197, 1936, 40 pp.

The following is the author's summary of the results. Records of the total horizontal illumination were obtained throughout the year 1927 with photoelectric cells and recording potentiometers simultaneously at the Hudson Street Hospital, at the lower end of Manhattan Island, N.Y., where the air was very smoky, and on Hoffman Island, in lower New York Bay, about 9 miles farther S, where the air was comparatively free from smoke. From these records the average hourly horizontal illumination has been calculated for each of these 2 places for each month of the year on clear days, cloudy days and all days. The daily average for each month and the hourly average for the year have also been calculated for each place. Both the absolute and relative losses of light from smoke at the Hudson Street Hospital have been determined from the records. The highest average daily horizontal illumination at Hoffman Island and at Hudson Street Hospital occurred in June and the lowest in Dec. The greatest total loss of light at the Hudson Street Hospital was in July and the least in Dec. The records showed a large relative loss of light due to smoke. In some cases the average hourly or daily % loss was >50. The average % loss for the whole year was 16.6 for clear days, 34.6 for cloudy days and 21.5 for all days. The % loss on cloudy days was, therefore, ca. twice as great as on clear days. An analysis of the results shows that the loss of light depends, among other things, upon the altitude of the sun, upon the nature of the daylight, whether from a clear or cloudy sky, upon the relative humidity of the air and upon the velocity of wind. The effect of the altitude of the sun upon the % loss of light is shown clearly in the variation of the % loss with the hour of the day. The average % loss throughout the year was 30.2 at 8:20 a.m., 16.5 at 1:30 p.m. and 21.0 at 3:30 p.m. The average monthly % losses showed no marked seasonal effect but did show a marked relation to the average monthly relative humidities, the % losses usually increasing and decreasing with the relative humidities. For clear days the greatest average monthly % loss was 23.1 in Nov. and the least 12.1 in May, with corresponding average relative humidities of 64.6 and 39.0%. For cloudy days these values were 52.7 in Sept. and 24.6 in Dec., with

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corresponding average relative humidities of 99.4 and 85.9%. Other conditions being the same, the average % loss of light was greater for cloudy days, or cloudy hours, than for clear days, or clear hours; the % loss being ca.1.5 times as great for cloudy days as for clear days for relative humidites between 40-80% and for wind velocities between 10.0-19.9 mph. For the same kind of sky, clear or cloudy, the average % loss of light increased with increase of relative humidity. For a clear sky the average % loss was twice as great for a relative humidity of 65% as for 35%. For a cloudy sky the increase was not as great. Also, % loss of light decreased as velocity of wind increased and was largely independent of the absolute humidity.

31. Prell, H.: Die Schädigung der Tierwelt durch die Fernwirkungen von Industrieabgasen. (Poisoning of animals at a distance by industrial fumes.) Arch. Gewerbepathol. Gewerbehyg. 7:656-70, 1936.

The investigation reported in this paper was brought about by the occurrences of a disease of unknown cause which within three years had affected and frequently killed 60-70% of the game of the Tharandt Forest in Saxony, Germany. The main symptoms observed were: abnormal and defective hair growth, hardening of the skin, cirrhosis of the liver and spleen, emaciation, as well as severe effects on the mucosae, connective tissues and antlers. In the same area, severe diseases coinciding with those described were also discovered in other animals, such as: in bees, deer, wild rabbits, fishes, cattle and silkworms. On the basis of various investigations, most of which are mentioned only in general terms, it was ascertained that these effects were due to As poisoning. The As, as a constituent of the waste gases of a plant, had been carried with flue gases over a considerable distance until it settled down on the plants of the forest. No results of air or plant analyses are reported. The author discusses the symptoms characteristic of As poisoning. As to its action on the organism, he distinguishes three different ways in which the poisonous dust may affect the body: 1) direct action on the skin or on the mucosae of the respiratory or gastrointestinal tracts, 2) indirect action on the organs and on the cytologic processes by As that had previously been absorbed and temporarily been stored in the body and 3) the effects causing dispositional changes, such as decrease in the resistance of the organism against temperature changes, infections or parasites.

It is stated that an examination of 41 red deer, 102 roebucks and 27 wild rabbits was carried out. However, the only analytical results reported are the following concentrations of As found in animals: 470 mg./kg. in the stomach content of a wild rabbit, 42 mg./kg. in the liver and 12 mg./kg. in the hair of an unspecified animal. The ratio of As content of severely to moderately affected hair (animal not mentioned) is given as 3.34:1. The MLD of As is given as 0.1-0.2 g. for bees and 0.06-0.2 g. As_2O_3 for man.

In the conclusion, some principal facts are summarized with regard to the As concentration of flue gases, the reach and distribution of these as well as to the effects of As and to the animals principally exposed. It is suggested that the findings reported might have some bearing on the problem of human exposure to flue gases.

32. Barrett, H.M.: Atmospheric pollution in Toronto, Canada. Can. Public Health J. 29:1-12, 1938.

Measurements of the amount of atmospheric pollution in Toronto, Canada for 1933-36 were made using the same methods as in Great Britain for comparison sake. Deposited impurities were collected by means of a funnel (area-ca. 4 sq. ft.) connected to a 20 l. bottle at 1 location outside the city (ca. 6 mi. out) and at 3 locations within the city: near large abattoirs, stockyards and railway sidings; business district near railway terminal and near public buildings and residential section. Monthly analyses of the deposited tar, C,

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ash, $SO_4^{=}$'s, NH_3, soluble and insoluble impurities and total solid were carried out. The results of each of these are tabulated. Total solids deposited at the city locations averaged 358, 610 and 341 tons/sq. mi./yr., respectively, compared with 133 tons/sq.mi./yr. at the rural location. Upon comparison with Liverpool, London, Birmingham and Glasgow for 1926-30, the amount of pollution settling in Toronto was as great as had been found in these badly polluted areas. A greater part of the the British deposit consisted of soluble impurity, while a greater of the Toronto deposit consisted of C. Suspended impurity was measured with an Owens automatic air filter. The curves of the average hourly variation of suspended impurity in Toronto for each month of the year show maxima occurring in the morning and evening which is also typical in Great Britain and the U.S. During the winter the average hourly suspended impurity was less than in London, but was almost identical with that in 5 U.S. cities showing maximum pollution. During the summer there was more suspended impurity in Toronto air than in these same 5 U.S. cities. The relatively small difference in air pollution found on Sundays and weekdays showed the greater part of Toronto's pollution to be of non-industrial origin. This difference in Toronto was of the same magnitude as in London.

On the basis of the results of this survey it is suggested that more adequate measures should be taken to control the smoke nuisance in Toronto.

33. Haythorn, S.R. and Meller, H.B.: Necropsy evidences on the relation of smoky atmosphere. Am. J. Public Health 28:479-86, 1938.

An attempt to correlate the high incidence of pneumonia with smoky atmosphere in Pittsburgh was made. It had been noted that the "smokiest" wards in the city, determined by sootfall studies in 1923-4, and 1929-30, had the highest death rates from pneumonia. However, the picture was complicated with other environmental factors, viz., economic conditions and occupational factors in these wards located in the valleys, along the rivers and railroads and in the vicinity of industrial plants. It had further been noted from time to time that following periods of several days of continuous smog, the number of deaths from pneumonia was increased. The mortality rate for the city from 1927-36 was reviewed. It ranged from 91.8-212.6/100,000 for pneumonia with the male death rate always being much higher than the female. From 1932-5 when the depression was at its height, when air pollution from industrial flues was greatly decreased and economic and living conditions at their worst, there was a great decrease in the number of deaths from pneumonia. This occurred in females as well as males, thus ruling out the influence of conditions within the plants as a factor. The protocols and microscopic sections of 3,000 necropsies were reviewed, the cases separated into pigment-free lungs and 5 grades of anthracosis depending upon the amounts of extraneous pigment and the fibrosis present. Grades O, I and II appeared to have no particular occupational basis. Grade III was a mixed non-occupational and occupational group. Grades IV and V were largely, although not exclusively, occupational. The incidence of pneumonia of "all forms" and of lobar pneumonia was tabulated in relation to each grade of anthracosis. In spite of the high local pneumonia death rate, no anatomical evidences of a relation between the incidence of pneumonia and the milder grades of anthracosis in the non-occupational groups could be demonstrated. In Grades III, IV and V there was a definitely higher percentage of pneumonia cases, but the average age for each of these grades coincided with the period of life at which the pneumonia death rate in less smoky communities is likewise highest. Healing by organization of unresolved pneumonia was

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consistently higher in all of the more advanced grades of anthracosis and greatest in Grade V. The organizing foci appeared to be associated with heavy pigment deposits, microscopic areas of fibrosis and isolated emphysematous pockets in fibrosed portions of the lung. Nothing tangible was found to connect the pigment deposits with the high pneumonia incidence and high mortality rates, but the association of severe anthracosis and healing by organization formerly reported was verified.

✓ 34. Schnurer, L.: Further studies on the relation of pneumoconiosis to respiratory diseases in the Pittsburgh district. J. Ind. Hyg. Toxicol. 20:14-23, 1938.
A series of 342 autopsies of adult patients of similar social rank, studied for the relation of dust deposits in the lungs to respiratory diseases, is reported. Some form of pneumonia was found in 48.24% or in 165 of the cases and was the cause of death in 14.32% or 49 of the cases. These rates, and the incidence of pneumonia cases in which organization occurred, were found to increase in direct proportion to the quantities of soot in the lungs. An analogous increase was found in the incidence of bronchitis and emphysema. Microscopic evidence of pulmonary t.b. was noted in 43.9% or 150 of the cases and 22.5% or 77 died from it. Accumulations of dust unaccompanied by SiO_2 did not dispose to t.b. Quiescent, rather than active lesions, were seen in heavily pigmented lungs when the pigmentation was caused by soft coal. Racial susceptibility in the Negro to the disease was evident. The type of dust present in the Pittsburgh district was largely made up of C particles and amorphous ash from soft coal. Very little free SiO_2 was present, yet the amount of fibrosis found about pigment-bearing cells was considerable, having been noted in 109 cases. While there was a relatively large number of cases of primary cancer of the lung, i.e., 16.2% of all the malignancies or 10 cases, the occurrence was interpreted in relation to the age group, since there was a concurrent increase in extrapulmonary malignancies. It is concluded that it cannot be said that the effect of soft coal smoke and dust on the lungs is entirely negligible.

✓ 35. Burdick, L.R. and Barkley, J.F.: Concentration of sulfur compounds in city air. U.S. Bur. Mines Inform. Circ. No. 7066, 1939, 14 pp.
This is a summary of the published results of various SO_2 investigations in the following cities: Chicago, Ill., 1937; Pittsburgh, Pa., 1927-32; Portsmouth, Va., 1926-27; Salt Lake City, Utah, 1919-21; San Francisco, Calif., 1913-14; Washington, D.C., 1926-28; Pittsburgh, Philadelphia, Washington, D.C., St. Louis and Detroit, 1936-37; other cities, 1936-37; Panama Canal, 1927-28; Berlin, Germany, 1922, 1931, 1937; Budapest, Hungary, 1932-34; Liège, Belgium, 1936; London and suburbs, England, 1923-27; cities of Great Britain, 1932-37; Prague, Czechoslovakia, 1929-30; and Austria, 1928. (26 references)

✓ 36. Elstad, D.: Manganholdig fabrikkrøg som medvirkende arsak ved pneumoniepidemier i en industribygd. (Manganese-containing dust as a predisposing factor for pneumonia epidemics in an industrial region.) Nord. Med. 3:2527-33, 1939.
This is a preliminary report on the results obtained from an investigation of the incidence of pneumonia in Sauda, Norway. During the past 15 years, the formerly healthy, rural community of 1500-2000 has trebled its population and has become an industrial district chiefly engaged in electrical smelting processes. The main products are Mn and its alloys. During the principal operation of the production process, great amounts of smoke are developed and given off into the air. The study revealed that in Sauda in the course of the past 15 years, the morbidity with regard to croupous pneumonia has been 4 times that of all Norway, while the mortality due to the same cause was 8 times that of the whole country. 32.3% of all deaths in

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that city are attributed to pneumonia. During the period 1930 through 1937, the number of fatalities resulting from pneumonia in Sauda for persons 15-29 years of age is given as 22/10,000, as compared with one fatality in the whole country during 1931 through 1935. This alarming situation can be explained neither by climatic nor by social factors. It was not possible to check this development by prophylactic vaccination which has been carried out since 1930. During the period 1930-1938, it became evident that the incidence of pneumonia was proportional to the output of Mn alloys in Sauda. Indicative evidence was obtained from autopsies of lung tissues, which demonstrated a marked increase in Mn content in the lungs of persons having died in that area.

A review of other publications provides grounds supporting the author's opinion that the inhalation of Mn reduces the resistance of the lungs against pneumococci and thus presents a predisposing factor in the reported pneumonia incidence. The situation is compared with the incidence of pneumonia due to the inhalation of Thomas slag dust, which contains 6-8% of Mn.

37. McMahon, J.F.: City air searched for sulfur fumes. Science 89:61-2, 1939.
A 15-month survey was conducted to determine average amounts of S gases in the air of more than 25 American cities. 5 metropolitan districts received more extensive study. Measurements were taken at all hours of the day and night and during all seasons of the year. Results varied from a high of 0.128 ppm in St. Louis to 0.009 ppm in Washington, D.C. It was concluded that the amounts (even the maximum reading of 2.266 ppm in St. Louis) were insufficient to cause harmful physiological effects. Home fires using high-S-content coal, which produced S gases, were found to be big contributors to the pollution. Concentrations were higher in the cold seasons or "heating seasons." A close relationship existed between wind velocity and pollution, the highest concentration being found on foggy nights. (Abst. Heimann, H. et al.: U.S. Public Health Service, 1950.)

38. Meller, H.B.: Practical procedures and limitations in present-day smoke abatement. Am. J. Public Health 29:645-50, 1939.
The magnitude of the job of smoke abatement is emphasized in this discussion which includes the following topics: the anti-smoke ordinance, the enforcement staff, the budget and products of combustion other than visible smoke. Practical suggestions for the accomplishment of smoke abatement are made. The most important of these is cooperation between the bureau of smoke abatement and the various groups with which it must deal. The limitations of methods and equipment are discussed.

A report on 100,000 questionnaires titled "Smog and You" used in the Pittsburgh area revealed that during smog 53% had nasal obstruction; 62%, a sense of rawness or tickling in the throat; 25%, increased coughing; 22%, increased "sinus trouble" and 9%, no complaints.

39. National Research Council of Canada: Effect of Sulfur Dioxide on Vegetation, Prepared for the Associate Committee on Trail Smelter Smoke. Ottawa, 1939, 447 pp.
This investigation is divided into 2 parts: field studies and fumigation experiments. In the 1st part the chapter titles include: sulfur dioxide in the atmosphere of industrial areas; symptoms of injury on forest and crop plants; the sulfur content of trees and shrubs in relation to sulfur dioxide in the atmosphere; the hydrogen ion concentration, base exchange capacity and sulfate content of soils; hydrogen ion concentration and sulfate content of water supplies; and the effect of sulfur dioxide on the diameter increment of conifers. The fumigation experiments

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include: description of plots and apparatus used in experimental investigations; fumigation experiments on conifers in their natural habitat; fumigation experiments on transplanted conifers; effect of environmental factors on the susceptibility of barley and alfalfa to sulfur dioxide; the stomatal behavior of fumigated alfalfa; experiments on yield of barley and alfalfa; effect of fumigation on some chemical constituents of barley, wheat and alfalfa; and carbon dioxide assimilation and respiration of alfalfa under influence of sulfur dioxide.

40. Roffo, A.H.: Sobre la existencia de hidrocarburos en el aire de la ciudad. (Presence of hydrocarbons in city air.) Bol. inst. med. exptl. estud. cancer 16:297-327, 1939.

Spectrographic analysis of air samples taken in Buenos Aires showed the absorption spectrum and the fluorescence characteristic for certain unsaturated polycyclic hydrocarbons. By means of air filters, a mineral oil was extracted from the air samples that demonstrated the same UV spectrum and fluorescence as has the oil collected by a filter attached to the tube of any carburetor. This demonstration of air pollution by car exhausts is considered to be as alarming as the fact that the substance extracted from the soot of petroleum stoves has an absorption of 2155-2642 Å, i.e., also similar to that of the carcinogenic hydrocarbons. The contamination of the city air in Buenos Aires is attributed to incomplete combustion in the various types of explosion motors. According to statistics obtained from the Board of Directors of the State's "Yacimientos Petroliferos," the fuel consumption in Buenos Aires in 1938 amounted to: fuel oil - 488,000 tons (582,000,000 l.), diesel oil - 53,000 tons (63,100,000 l.), gas oil - 34,500 tons (41,220,000 l.) and gasoline - 300,000,000 l. This represents a total volume of 986,320,000 l. of fuel.

Experimentally, a filter was attached to the exhaust pipe of a car (with the motor in perfect condition). The substance collected on the filter contained 0.11 g. of mineral oil / 5 km. of driving distance (i.e./1 l. of gasoline). The corresponding figure, calculated on the basis of the above mentioned fuel consumption in Buenos Aires, would amount to 108,495 kg. of mineral oil escaping yearly into the atmosphere in that city, not including the contamination due to other sources of combustion.

The various components of mineral oil are discussed in relation to their physiologic action, particularly S which produces H_2SO_4. Further, cancerigenic polycyclic aromatic hydrocarbons were detected as the chemical products of petroleum distillation, e.g., anthracene, phenanthrene, retene and chrysene. The factor of cigarette smoking with regard to air pollution is mentioned. The relationship of the increase in the incidence of lung cancer and other cancers of the respiratory organs with the constant rise in air pollution is discussed, and the importance of prophylactic measures in the control of the contamination of the atmosphere is pointed out.

41. Singh, A.D.: A survey of sulfur dioxide pollution in Chicago and vicinity. A report of an investigation conducted by the Engineering Experiment Station University of Illinois in cooperation with the Smoke Inspection and Abatement Department, City of Chicago, Univ. Ill. Bull. 36, No. 37, Jan. 3, 1939, 32 pp.

In Jan., 1937, a preliminary survey of the SO_2 concentration in the air over Chicago was undertaken to locate the principal sources of SO_2, to determine the amount given off from them and to determine the general SO_2 concentration over the city. The apparatus and analytical procedure are described. Low chimneys, whether domestic or industrial, discharging gases resulting from the combustion of high S fuels, contributed the major portion of the pollution. In the downtown business district including the Loop, the

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Singh, A.D. (continued)
concentrations encountered did not vary a great deal ragardless of wind direction and of wind velocity; they ranged mainly from 0.20-0.50 ppm with an average 0.41 ppm. About 50-70% of the pollution in this area resulted from the Loop itself and the vicinity. Residential districts in the N, NW and extreme S had the lowest concentrations of SO_2. In the W side residential district, which included small industries and business houses, concentrations ranged 0.1 in summer - 0.2 in winter. The congested residential districts located between 22nd and 63rd streets on the S side had concentrations averaging ca. 0.3 ppm. Outlying residential districts, e.g., Evanston and Willmette, showed only negligible concentrations of 0.05-0.09 ppm SO_2. Under normal weather conditions the contribution of most industrial plants using high S coals to the general pollution is not considered to be serious; normal average on leeward side of stacks was 0.29 ppm. Under special weather conditions, such as foggy days or gusty winds, such industrial plants created SO_2 concentrations near the ground several times greater than normal, as high as 0.8-1.0 ppm. The pollution in outlying manufacturing districts varied a great deal. The steel mills, usually the smokiest and the dustiest of all industries tested, gave an average SO_2 concentration of 0.05 ppm, while tests on the leeward side of some industrial plants gave concentrations of 0.8-1.46 ppm. In certain railroad stations concentrations of SO_2 ranging from 1-3 ppm were found. In the leeward direction of locomotive round houses concentrations of 0.17-1.61 ppm were found, with an average of ca. 0.67 ppm. Such concentrations were always present for several hours of the day. The air in the stock yards showed neutral to traces of SO_2. This is probably due to the neutralization of SO_2 by the products of decomposition of the organic matter. The air conditioning units used in some office buildings reduced the concentration of SO_2 in the building.

42. Leonard, A.G.G., McVerry, B.P. and Crowley, D.: Atmospheric pollution in Dublin during the year 1939. Sci. Proc. Roy. Dublin Soc. 22:257-65, 1940.

A report on air contaminants listing the various types is presented for the year 1939. Graphs indicate monthly levels of suspended impurities. Other measurements include SO_2 and sunlight. Pollution by suspended matter is compared with the deaths from respiratory diseases. It is a well-established fact that the death rate from respiratory diseases is higher in cities than in rural areas, and in larger cities, e.g., Manchester, periods of fog are followed by a rise in the death rates from such diseases. City fogs are due to an increase in the amount of suspended matter in the air. A graph comparing the intensity of air pollution each week with the weekly total of deaths from respiratory diseases in Dublin shows markedly similar curves. It is concluded that any pronounced rise in pollution during the winter is followed shortly by a rise in the death rate. High pollution by suspended impurity is accompanied by corresponding high pollution by SO_2, and periods of high pollution by these impurities are always periods of low temperature. Death rates of Dublin County and the city are compared, showing a marked increase in the city, due allegedly to air pollution. (Abst. Heimann, H., et al: U.S. Public Health Service, 1950.)

43. Jötten, K.W.: Zur Frage der Schädigung der Anwohnerschaft durch den Abrauch und die Abgase von Industriebetrieben. (The question of injury to the neighborhood by exhaust fumes and gases of industrial establishments.) Arch. Hyg. u. Bakteriol. 125:239-72, 1941.

The author reports on several of his investigations to settle controversies on the alleged harmfulness of industrial waste gases. In all instances, numerous air samples were collected under various metereologic conditions and at various distances from the source of contamination. The physiologic action of the respective substances detected on analysis is discussed. 1) Smoke, given off by a burning slag pile, was found to contain: mercaptans, H_2S, SO_2 and NH_3 (no concentrations are given). Protests that it represented a hazard for persons living at 65 m. distance were rejected, since the smoke was immediately diluted by the air and since on examination, no pathologic changes were detected in these persons. 2) Another slag pile gave off smoke containing SO_2, present at 10 ppm at the slag pile and in traces near the living quarters of the workers. A marked disturbance in the chlorophyll formation was observed in the plants growing near-by. It was advised to discontinue the use of the living quarters. 3) Construction workers were exposed, during work, to the inhalation of smoke, noticeable by a pungent smell and a severe effect on the conifers growing close-by. Analyses of air samples revealed the presence of H_2SO_3 at the following concentrations (mg./l. of air): 0.029-0.30 at the working place and 0.125 near the workers' quarters. 2 groups of construction workers, 13 and 24, respectively, ranging in time of employment from 2 weeks to 10 1/2 years, were questioned, and blood samples were taken. The findings included the symptoms typical for the action of SO_2 and high values for Hb (range: 72-126%) and for lymphocytes (22-54%). These findings resulted in an improvement of the hygienic control and the removal of the workers from the present quarters. 4) In another instance, objections to the construction of a galvanizing plant, based on fear of its allegedly injurious effluents, were rejected. In previous investigations in 2 different galvanizing plants, the author had found no effect on workers with exposures extending over "several decades" and had detected only 0.149 and 0.217 mg. Zn/l. of air, respectively, at the Zn vats and traces at a distance of 3-40 m. 5) The investigation of the harmfulness of exhaust gases given off by a gas-producing plant included three main studies: a) 23 persons, selected at random from workers and employees of the plant, had neither complaints nor objective signs of poisoning; neither had the inhabitants of the houses in the vicinity of the plant. b) Air samples of 25 l. each were analyzed for: CO_2, CO, NH_3, HNO_2, H_2SO_3, H_2S, CS_2, C_2H_2, $C_3H_5^-$, $(CN)_2$ and C_6H_6. Some substances were present in traces, none at concentrations injurious to health. c) Mice and rabbits, after having inhaled air from the collected samples, showed no changes in physical condition or in the composition of their blood. Also, this air, made to flow through the blood of sheep, did not affect it in any way. It was concluded from the above results that the effluents of the plant, even though malodorous, did not represent a hazard to the health of the exposed persons.

44. Youden, W.J.: Fluctuations of atmospheric sulfur dioxide. Contrib. Boyce Thompson Inst. 11:473-84, 1941.

Examination of a continuous record of SO_2 concentration in the atmosphere at Boyce Thompson Institute shows a daily cycle which changes form during the seasons. In the winter months the concentration builds up during the day to ca. 60 ppm and falls off to ca. 35 ppm in the night. In other seasons a drop to ca. 10 ppm occurs in the early afternoon and is probably the result of northerly breezes at that time of day. These concentrations are for the average cycle. There is a weekly cycle, found at all seasons, in which the concentration is low on Sunday and Monday and increases by about 50% to a maximum on Thursday and Friday. The annual cycle follows a sine-shaped

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Youden, W.J. (continued)
curve with a minimum of 15 ppm SO_2 in the summer to a maximum of 50 ppm in the winter. The influence of the weather was brought out by driving regression equations which show a strong correlation of SO_2 concentration with wind direction and velocity, temperature and, to some extent, with rainfall.

45. Mills, C.A.: Urban air pollution and respiratory diseases. Am. J. Hyg. 37:131-41, 1943.

A study was made of the relationship between air pollution and respiratory disease, with a comparison between Cincinnati and Pittsburgh. The sootfall and pneumonia rates were found to be much higher in Pittsburgh. In both cities, sootfall and pneumonia rates were higher in the low-lying industrial areas. A similar, close relationship was found with t.b. Socio-economic indexes compared favorably with the results to add another possible causative factor. The increased incidence of pneumonia in men was attributed to greater exposure in view of the insignificance of the sex difference in rural areas. The winter smog is discussed as an important agent in the incidence of pneumonia. The possibility of carcinogenic material in smoke is also mentioned. Recommendations are made for reducing air pollution: the use of low-volatile coal, fly-ash trapping, preliminary coal washing and use of diesel locomotives. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950)

46. Dean R.S. and Swain, R.E.: Report Submitted to the Trail Smelter Arbitral Tribunal. U.S. Bur. Mines Bull. 453, 1944, 304 pp.

This report presents an extensive study of the operational features of Trail Smelter and especially of the meteorological situation in the Columbia River Valley near Trail, B.C. (the latter study by E.W. Hewson and G.C. Gill). The 3rd part of the report presents the seasonal meteorological control measures adopted during a trial period, with the corresponding record of smelter operation and SO_2 recording. SO_2 concentrations ranged up to 2.40 ppm. In conclusion it is stated "that the extensive investigation of air movements in the Columbia Valley which has been in progress for over 2 years past with relation to the distribution of SO_2 from the smelter stacks has indicated that these movements may be sufficiently rationalized to make possible the control of the gas concentrations occurring across the International Boundary in the U.S. on a meteorological basis. It has not been possible during the relatively short period this investigation has been in progress to reduce such meteorological control measures to a hard and fast regime. But much progress has been made and the ground work for the development of a simplified and sound practice has been laid." In the author's judgment, "if an intelligent attempt is made to make use of the guiding principles set down in this report and to test and improve them during periods of greater SO_2 emission that may occur in the future, a complete solution of the problem of damage to vegetation in the U.S. can be reached without an arbitrary limitation on the total amount of SO_2 emitted by the smelter."

47. Atmospheric Pollution Research Committee (Dobson, G.M.B., Chairman): Atmospheric Pollution in Leicester. A Scientific Survey. Dept. Sci. Ind. Research, Technical Paper No. 1, London, H.M. Stationery Office, 1945, 161 pp.

The purpose of this survey of Leicester was (1) to measure and investigate the distribution of atmospheric pollution in the neighborhood of an industrial town; (2) to determine the principal agents causing

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Atmospheric Pollution Research Committee, et al., (continued)
atmospheric pollution; (3) to measure how atmospheric pollution varies, e.g., with the habits of the population and with meteorological conditions and (4) to find out how pollution escapes from the atmosphere of a town.

The instruments used were the volumetric SO_2 apparatus with smoke filter attachment, the automatic filter measuring hourly mean concentration of black suspended material, and the newly designed daylight integrator for the measurement of UV daylight. In addition, the standard deposit gauge and the PbO_2 apparatus which give monthly readings were used. Each of the instruments are described in detail. 12 sampling stations were located throughout the city: 1 at the center of the city, 3 on the outskirts of the industrial area, 6 in the suburbs and 2 in the country. The results are tabulated and contour lines of equal pollution are drawn on maps of the city. The lines form ellipses elongated to the N and S, just as the industrial and residential parts of Leicester are elongated. On weekdays in winter, the pollution was 2-3 times as much as in the summer, i.e., ca. 42 mg. smoke/100 m.^{3} as compared to 17 at the center of the city and ca. 20 vs. 7.5 in the suburbs. Similarly, concentrations of SO_2 (volumetric method) varied 13.5 pphm vs. 6.0 at the center and 5 vs. 2 in the suburbs; by the PbO_2 method, the values compared 4.5 mg. SO_3/day/100 cm.^{2} vs. 1.8 in the center and 1.6 vs. 0.75 in the suburbs. On Sundays the concentrations were less than on weekdays by ca. 1/2-2/3 for both summer and winter. The mean distribution of UV daylight did not vary appreciably between Sundays and weekdays in winter. Differences in losses of UV radiation were more difficult to detect in summer. A thorough survey of deposited matter was not made but it was noted that total undissolved matter, undissolved ash, tar and other combustible matter diminished with distance from the center of Leicester at a rate faster than, or comparable with, smoke and SO_2, and total dissolved matter, dissolved $SO_4^=$ ion, Cl^- ion and NH_4^+ ion diminished with distance from the center of Leicester at a much slower rate. Distribution of pollution is further discussed with respect to mean wind directions. During calm weather, absolute concentrations of pollution were very variable, smoke concentrations ranging from 0.5-5.0 times the normal concentration and SO_2 from 0.6-3.2 times the normal concentration. This is attributed to turbulence. Distribution of emission is also discussed.

The yearly cycle of suspended smoke and SO_2, of deposited matter and of UV daylight and the weekly and daily cycles for smoke and SO_2 were analyzed. The irregular variations of deposited matter, smoke, volume of SO_2 and SO_2 by the PbO_2 method are also discussed especially with respect to wind direction and velocity, temperature gradient, turbulence and rainfall.

The practical aspects of abatement and control, of measurement and of future research are discussed.

✓48. Murray, M.M. and Wilson, D.C.: Fluorine hazards with special reference to some social consequences of industrial processes. Lancet II: 821-4, 1946.

An outbreak of F poisoning in cattle had drawn attention to possibilities of public health hazards from F. Green (1946) had identified the cause of lameness and cachexia in some Lincolnshire cattle as an effect of the local burning of ironstone. The authors have studied conditions in the household of a farmer living nearby in the midst of his fields. (The distance between the house and the works is not stated.) The direction of the prevailing wind was shown by deterioration in the growth of field crops in the immediate vicinity of smoke emanating from the open calcining of ironstone. Wheat and barley embryos did not mature, and it was customary for farmers to obtain compensation from the mine owners based on the difference between the expected and actual grain yield. At the height of calcining the density of fumes could even make driving on neighboring roads difficult. Nine members

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of the household of this farm complained of gastric upsets, pulmonary distress, pains and stiffness in legs, knees, etc. F content of urine ranged from 1.6-4.2 ppm. Radiologic findings were negative with respect to fluorosis. Teeth showed mild to moderate mottling. Two samples of well water contained 0.4 and 0.6 ppm F. Etching of window glass on the side of the house facing the fumes was explained to be due to the action of HF. The house was poorly constructed, so that fumes entered the home, settling on the food, which also became covered with red dust when the calcined ore was loaded for dispatch. During the 6 years since the increase in ironstone operations, loss in livestock was experienced. Vegetables grown on the farm were of poor quality. Surface contamination of food with F may explain raised urinary F levels. At a farm adjacent to ironstone pits fron which the ore was sent directly to blast furnaces without local calcining there was no history of illness in either the members of the household or in their farm stock. Their domestic water had 0.35 ppm F in wet weather. Inspection of adolescents in 5 neighboring villages showed teeth with a "very mild" degree of mottled enamel. At the blast furnace no history of clinical disability attributable to F was obtained from workmen employed for >15 yrs. (This appears to be an extreme case. The author states that substitution of closed kilns would make the amount of F in the ore and coal immaterial from the public health viewpoint. Since urinary F was not unduly high and no atmospheric concentrations are given, the question may be raised whether the dense smoke and fumes in general were not chiefly responsible for the gastric and respiratory distress. IRC.)

49. **Chasis, H., Zapp, J.A., Bannon, J.H., Whittenberger, J.L., Helm, J., Doheny, J.H. and MacLeod, C.M.:** Chlorine accident in Brooklyn. Occupational Med. 4:152-76, 1947.

A tank containing approximately 100 lbs. (45.4 kg.) of Cl_2 being transported by truck accidentally emitted the liquid gas from a 1/8" (0.32 cm.) orifice for 17 min. No visible cloud formed on the street except in the immediate vicinity of the truck, although the odor of Cl_2 was detected 800-1,000 ft. (244-305 m.) downwind. The concentration of Cl_2 in the street and in the immediate vicinity was high enough to drive people indoors for a few minutes, but a search of hospital records revealed only 2 casualties with a history of exposure on the street. A casualty-producing concentration of Cl_2 was built up in the station of the subway due to liberation of the Cl_2 in close proximity to the subway entrance and ventilation gratings, the tendency of the dense gas (its density is 2.49) to settle to low levels, and the piston action of subway trains in pulling the gas into the station. Of 133 persons admitted to Cumberland Hospital 33 were hospitalized for 1-2 weeks and serve as the basis for the description of the symptoms, pathologic changes and clinical course of moderately to severely affected patients and for the evaluation of therapy. The symptoms that occurred during the 1st few hours after exposure consisted of burning of eyes with lacrimation, burning of nose and mouth with rhinorrhea and increased salivation, cough, choking sensation and substernal pain. These were frequently accompanied by nausea, vomiting, headache and dizziness; syncope occurred infrequently. Except for cough, substernal pain and respiratory distress, immediate symptoms subsided within 24 hr. The significant changes in the respiratory tract consisted of tracheobronchitis, pulmonary edema and pneumonia. Tracheobronchitis was evident in all 33 patients within 24-48 hr., subsiding in most instances in 5-7 days. Pulmonary edema, chiefly basilar in location, was observed in 23 out of 30 patients. In 14 pneumonia developed; in 13 the pneumonitis was basilar and in the 14th it was hilar. 12 of the 14 patients in whom pneumonia developed had pulmonary edema. Except in 3 patients, the

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clinical course of the pneumonia was relatively benign.

Eleven of the 33 patients who were observed for 16 months after discharge from the hospital had no symptoms attributable to exposure to Cl_2. 16 patients had anxiety reactions, with phobias, hysterical phenomena and psychomotor dysfunction persisting for 1-16 mo. There was no evidence that Cl_2 intoxication produced pulmonary disease in any of the patients who were followed for 16 months.

50. Galloway, R.M.: Smoke abatement in relation to public health. J. Inst. Fuel 20:194-5, 1947.

In the author's opinion, there is sufficient SiO_2, C, tar and SO_2 in the air of most industrial areas to cause some degree of pulmonary fibrosis, to irritate the respiratory mucous membranes and to predispose to respiratory diseases. The rising incidence of cancer of the lungs, the exact cause for which is unknown, is pointed out, although some blame it on road dust. Sunlight is reduced about 50% by smoke with a resultant reduction in the feeling of well-being, both physiologically and psychologically. While obvious, the effect of this reduction is difficult to measure. Foggy periods tend to increase the deaths from respiratory disease, and increases the incidence of pneumonia and acute bronchitis in the young and old. The average death rates from bronchitis, pneumonia and other respiratory diseases for 1933-42 are compared for the highly polluted towns of Manchester and Bolton and the relatively cleaner towns of Northampton and Coventry; the death rates are much lower for the latter 2 towns.

✓ 51. MacGregor, A.M.: Smoke and the public health. Med. Officer 78:157-9, 1947.

There is evidence that during the past quarter of a century the production of smoke has been reduced, and its ill effects on health have diminished. The deleterious effects of smoke are worse when fog and frost are combined with smoke. The mortality from pneumonia and bronchitis is increased during a smog and for weeks thereafter. One of the worst examples was a fog of 75 hours' duration, accompanied by frost and influenza, in Glasgow in Jan. 1929, when the death rate rose to the high figure of 50.3/1,000 population in the 3rd week of the month as compared with 15.3/1,000 for the whole year. In 1928 Manchester had 13 days of fog during Feb., the death rate rising to 34.4/1,000 by the end of the month, as compared with the annual rate of 13.2/1,000. Leeds experienced the same due to a 6-day fog. Smog irritates the mucous membrane of the respiratory tract and is especially felt by elderly people with a tendency to bronchial catarrh. These people are the first to become ill when a smog appears. Of the Glasgow deaths, 49% were due to respiratory diseases. Smoke is thought to be responsible, at least in part, for the higher mortality rates of children under 5 years of age from pneumonia and bronchitis in 1 of the industrial towns. It is estimated that smoke eliminates 50-80% of the sunlight and is thus detrimental to health. A table demonstrates the loss of daylight and UV radiation in the center of an industrial town as compared with that of the country. A recent publication by the Department of Scientific and Industrial Research states that in the towns and cities of the British Isles there are many people whose state of health would be improved by more sunlight. (Abst. Heimann, H., et al.. U.S. Public Health Service, 1950.)

✓ 52. Ely, S.B.: General atmospheric pollution. Some work in Pittsburgh air pollution problems. Am. J. Public Health 38: 960-1, 1948.

It was found that the average dust collected in Pittsburgh by sucking air through paper tape was about the same when the steel mills were shut down, running 60% production. and at full production. The values were 1.77, 1.61 and 1.68 units/hour, respectively; these units were arbitrary numbers to

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indicate the relative densities of the dust spots. It is, therefore, not plant production causing the pollution, but some other factor. The spots further showed that the dust was deposited more heavily in the mornings and nights, while in the middle of the day the tape was almost white. This indicated inversion, which usually occurs in the mornings and nights, to be the controlling factor in the amount of dust in the air.

53. Halley, P.D., Wilson, G.L. and Salazar, A.: Atmospheric Pollution Investigation, Metropolitan Area, Charleston, W. Va. West Virginia Department of Health, Bureau of Industrial Hygiene, 1948, 24 pp.

A survey of atmospheric pollution extending from Belle, W. Va. to St. Albans, W. Va. was undertaken by the Bureau of Industrial Hygiene, W. Va. Dept. of Health from May 28, 1945 - Dec. 31, 1947. The amount of sootfall precipitated in the area and the proportions of combustible matter (C) and ash in the sootfall were determined. These were compared with sootfall data from other cities in the U.S. Dust particle size was measured and the prevailing wind direction and velocities were determined. Studies of the rate of corrosion or rusting of steel plates placed at different points in the area and in 7 other industrial cities in W. Va. were made for ca. 1 year. The weight of settled solids and % C and ash are tabulated on a monthly basis by station; these are averaged for each season and also for each year. The areas receiving the highest rate of sootfall were Belle, South Charleston and North Charleston, and the least was the control station, 8 mi. up Elk River. The yearly averages reveal some reduction in sootfall at some points during 1947 in comparison to 1945 and 1946, while some stations remained the same or actually slightly increased. In 1945, the values at the sampling stations ranged 358 - 1858 tons/sq.mi./yr. as compared to 120 at the control station, in 1946, 339-4695 as compared to 147 and in 1947, 454-3634 compared to 160, respectively. Compared with other U.S. cities, e.g., Cincinnati, O., Rochester, N.Y., New York, N.Y. and Detroit, Mich., the Charleston Metropolitan area was the most polluted. The size of the particles indicates that they are small enough so that a great % could be carried the entire distance between the 2 major areas of pollution, Belle and South Charleston. The amount of corrosion of steel plates ranged 0.003649-0.011835 in./yr., as compared to 0.001156 in./yr. at the control station.

54. Mills, C.A. and Mills-Porter, M.: Health costs of urban air pollution. Occupational Med. 5:614-33, 1948.

The sootfall in tons/sq.mi./mo. for Jan., Feb., Nov. and Dec., 1946 are compared with white male death rates/100,000 in 1944-46 for pneumonia, pulmonary t.b. and respiratory cancer: total, buccal tissues and respiratory tract, for the 23 districts in Chicago. Deaths from t.b. and pneumonia increased 10 times more in white males than in white females on going from cleaner suburban areas to the dirty Loop district. Total respiratory cancer rates for males increased 42%, those for buccal cancer alone - 88% and those for cancer of the respiratory tract - 34%; the rates were lower for females in the dirtier areas. It is shown how extremely unlikely it is that this relationship between respiratory disease death rates and sootfall was of chance occurrence.

Sootfall data were available for the winter (Nov.-Feb.) 1941-42 for 20 collecting stations in Detroit. These are compared with the annual death rates/100,000 in 1942-46 for pneumonia, pulmonary t.b. and respiratory and buccal cancer. Pneumonia and t.b. rates rose about 2.5 times as much for the males as for the females on going from the cleaner to the dirtier districts, while the combined buccal and respiratory cancer death rate rose 4.6 times.

The average monthly sootfall over Pittsburgh from Apr.'38 - June '40 is

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compared with the annual death rates/100,000 for pneumonia and pulmonary t.b. in 1930-31. Extremely high death rates among white males prevailed in Pittsburgh's low-lying, river-front districts before the days of serum or chemotherapy. The death rate among females is much less. A survey of these death rates for 1944-46 to give a better comparison is not yet ready for publication.

Average monthly sootfall for 1930-40 is compared with pneumonia and t.b. death rates/100,000 for 1929-31 in 19 districts in Cincinnati. Again the male death rate is much greater than the female rate in the dirtier areas. Buccal and respiratory tract cancer death rates for 1940-45 show a 159% increase from clean to dirty areas for males and an 18% decrease for females.

The census tracts in Atlanta, Ga. were divided into clean, intermediate and dirty categories and compared with death rates for pneumonia, pulmonary t.b. and respiratory and buccal cancer. For white males the death rates increased 71, 110 and 76%, respectively, from clean to dirty areas. For females the rates increased 135 and 35% for the first two, but decreased 27% for the respiratory cancers.

Average monthly C deposit in Nashville, Tenn. for Oct. '36-Jan. '39 (since sootfall data were not consistent for soluble and insoluble ash) is compared with pneumonia and pulmonary t.b. death rates for 1944-46 by sootfall station. Grouping the stations together into clear, intermediate and dirty areas, pneumonia and pulmonary t.b. death rates from low to high pollution areas increased 66 and 131%, respectively, for white males, 162 & 100%-white females, 57 &145%-Negro males, and 84 & 32%-Negro females.

The authors estimate that 700 excess deaths occur in the dirtier sections of Chicago due to air pollution or other regional factors. The 10-fold difference in excess deaths between males and females in dirty districts is accounted for by more daily hours of exposure to the dirty air and greater smoking habits of males.

55. Agate, J.N. et al.: Industrial Fluorosis. A Study of the Hazard to Man and Animals near Fort William, Scotland. A Report to the Fluorosis Committee. Medical Research Council Memorandum No. 22, 131pp., 3 maps, 13 plates. London, H.M. Stationery Office, 1949.

I. Studies of the contamination produced in the Fort William area by fluorine compounds. R.G. Bowler, M. Buckell, H.A. Druett and J.D. Richardson.

This part of the report deals with the environmental features, topography, meteorology, geology and industry in the Ft. William and Kinlochleven areas in Inverness-shire, Scotland. The Ft. William aluminum factory is situated at sea level at the junction of 4 valleys, the largest of which, Glenmore, NE of the factory, increases in width from 2-6 mi. at 7 mi. distance. The NW wall of this valley consists of a chain of hills varying in height from 1,000-2,500 ft.; to the S, the Ben Nevis range of mountains, rising immediately from the SE of the factory, runs up to 4,406 ft. Lower hills, up to 750 ft., occupy the N half of the valley. SW of the factory, Upper Loch Linnhe, about 1 mi. wide, lies between hills rising to 2,000 ft. NW is the valley of Loch Eil, which is about 3/4 mi. wide and also lies between hills about 2,000 ft. high. The narrow Glen Nevis extends to the S, having Ben Nevis on the E side and hills rising to 1,000 ft. on the W. The areas between these valleys are mainly mountainous country. The village of Inverlochy is 1 mi. W of the factory. Kinlochleven is 9 mi. S of Ft. William, and the high lands of the Mamore Forest lie between the 2 places. The Kinlochleven factory is surrounded on 3 sides by hills between 2,000 and 3,000 ft. high and is situated at the E, inland end of Loch Leven, which is connected with Loch Linnhe and the sea. The prevailing winds are S or SW, to less extent N and NE. The soil surrounding the factory at Ft. William

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consists mainly of peat overlaying a bed of rock. As a consequence of the heavy rainfall and the poor drainage afforded by the rocky lower layer the soil is always wet. Coarse grasses, sphagnum moss, heather and bracken are the characteristic herbage, and clumps of spruce, fir and pine trees are to be seen on the low ground about a mile NE of the factory. The streams are lined mainly with common alder and dwarf birch. The factories under consideration are engaged in the manufacture of Al metal by the electrolytic reduction process. The factory at Ft. William consists of external installations, a carbon factory, and the main factory with associated offices. That at Kinlochleven is an older factory but contains the same type of plant. The operations and working conditions are fully described. The F concentrations in the furnace room at Ft. William ranged from 0.14-3.43 mg./m.^{3}, with highest values in the older buildings, and with samples taken in war times when due to blackouts, ventilation was reduced. In those at Kinlochleven, F ranged from 0.34-0.91 mg./m.^{3}. The percentage of gaseous to particulate F showed great variations. In the evaluation of the atmospheric contamination, samples were taken of the blood and urine of both workers and persons residing in the area (analysis of human teeth was also made); samples of the atmosphere, of the soil, grass and water, and animal specimens were collected. The concentrations of F in the atmosphere outside the factory at various distances on different days, varying with wind direction and wind speed at time of sampling, ranged from 0.020-0.220 mg./m.^{3} of air (highest value 200 yards SW of factory). The gaseous F (as percentage of total) ranged from 15%-81%. Particulate F as percentage of total ranged from 19%-85% in completed analyses. The F content in soil samples in various localities ranged from 101 ppm (dry weight) (ESE) to 677 ppm (NE) taken at 1/4 mi. from the factory, 57 ppm (SSE) to 703 ppm (NE) at 1/2 mi., 24 ppm and 66 ppm at 7 mi. distance (NE). 12 ppm (lowest value given) was found 1 mi. W of the factory. Control samples, at 25 and 30 mi. distance from factory, were 8 and 13 ppm, respectively. Concentrations of F in soil samples taken at varying depths from a point in the NW corner of the factory grounds were found to be: for 0-1 in. depth of sample, 1,010 ppm F (dry weight); for soil of 11-15 in. in depth, 161 ppm. The vegetation in the prevailing wind direction (NE) ranged from 1,104 ppm (dry weight) at 1/2 mi. from the factory to 35 ppm at 6 mi., and 5 ppm at 7 mi. (NE). The control samples taken at 25 and 30 mi. distance (WNW) were 3 and 5 ppm, respectively. Concentrations of F in water samples were found to range from 0.04-0.77 ppm. Control samples contained 0.04 and 0.00 ppm.

II. Effects of fluorine compounds on animals in the Fort William Area. G.F. Boddie.

The discovery of evidence of fluorosis among livestock in the Fort William area led to an investigation of this condition. In Nevis Bridge Croft and Achintee farms, situated 1/2 and 2 mi., respectively, from the factory of the British Aluminum Company, Ltd., sheep and cattle revealed abnormal condition of teeth of varying intensity. The animals of the Nevis Bridge Croft farm exhibited no other changes except for debility. Those of the Achintee farm showed also an unusually large number of fractures. At Torlundy farm, about 1 3/4 mi. N of the factory, in the entire herd of 45 animals the majority of dairy cows were found to be in poor bodily condition; the coats were dull and the skins were hard. Abnormalities of the incisor teeth of the adult animals were mottling of enamel, delayed eruption, deformities, etc. On another farm, Achendaul, 4 1/2 mi. NE of factory, with grazing to within 2 mi. of it, cows showed definite dental fluorosis as did those at Achintore, 2 mi. SW. At the latter place, stiffness and lameness were also observed. Animals from

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these farms, removed for observation, showed decided lesions of the teeth and bones as did sheep obtained for the same purpose. Analyses of tissues and urine showed F concentrations as follows: Affected sheep: teeth, 3,500-6,100 ppm (dry weight); mandible, 2,140-17,000, control 111-415 ppm; heart 6.8-20, control, 4-12.7 ppm; liver 5.7-17.6, control, 3.7-18.6 ppm; brain, 25.2-102, control, 5-19.2 ppm; kidney, 21-54.7, control, 2.2-11.4 ppm; lung, 12.3-39.5, control, 3.1-7.1 ppm; rib, 7,000-12,000, control, 83-478 ppm; radius and ulna, 1,010-10,300, control, 99-279 ppm. Affected cattle: liver, 3.5, control, 0.6-2 ppm; brain, 18, control 4.4-14.6 ppm; kidney, 15.4, control, 2.5-2.8 ppm; ribs, 3,220-9,100, control, 92.2-114.2 ppm; mandible, 4,360-9,200, control, 52.2-103.7 ppm; radius and ulna, 4,850-9,600, control, 68.5-98.5 ppm; teeth, 3,460-7,600, control, 58-94.4 ppm; rumen contents, 100.3, control, 2.5-7.9 ppm. Urinary values were 13.6-41 ppm within 2 mi. of factory. Urine from cows 4 1/2 mi. N of factory was 14-20 ppm. The milk of affected animals contained 0.11-0.62, controls, 0.00-0.79 ppm. Because of the topography, no fluorosis was found in the neighborhood of the Kinlochleven factory.

III. Clinical, radiological, haematological and biochemical findings in selected groups of individuals from the districts of Fort William and Kinlochleven. J.N. Agate, D. Hunter and K.M.A. Perry, assisted by J. Garrad and E.A. Cheeseman.

At the time of the clinical examination, 668 men and 114 women were employed at the Ft. William plant. Two groups within the factory population were selected: I. Those exposed directly to F-containing fumes, i.e., those working in the furnace rooms; this included 220 men (61% of the total) and 22 women (52% of the total), as well as 12 men from the Kinlochleven plant selected for length of service, 24-42 yrs. II. Of the remaining employees, 44 men and 25 women volunteered. Physical examinations included particular attention to the movements of the thoracic cage, joints, spinal column, X-rays, blood and urine examinations. Within the factory, there was very little evidence of organic disease of a general nature and still less of abnormal physical signs which could be attributed to occupations. A proportion of furnace room workers, greater than in the control groups, complained of cough and various digestive symptoms mostly slight, and not easy to relate to employment with any degree of certainty. Hemoglobin levels and blood counts were within normal limits. X-ray examinations of workers showed abnormalities in a number of cases increasing with length of exposure although no disabilities were observed. Two case histories are presented. One was that of a relatively young man who had been exposed to F for 15 years and whose vertebral column was described as having a bamboo spine, showing osteoporosis. This man was considered to be suffering from ankylosing spondylitis and not from skeletal fluorosis. Blood count was normal. Blood F was estimated at 0.4 ppm; urinary F was 2.1 mg./24 hours. The other case involved an older man who had been exposed to F for 35 years and whose vertebral column showed extensive lipping and marked increase in opacity to X-rays. There was no recognizable disability. The urinary F was 14.9 mg./24 hours; the blood F, 3.5 ppm. The mean blood and urinary values were as follows: Mean blood F for fully exposed furnace room workers, male: 2.13 ppm; of partially exposed males 2.00; of women 1.31 ppm; of males in other parts of factory, 2.21 ppm; of females, 2.91 ppm. The mean urinary F for fully exposed males was 9.03 mg./24 hours, of partially exposed furnace room workers, male, 5.19 mg./24 hours, of females, 3.64 mg./24 hours. Male workers in other parts of factory showed 1.83 mg., female, 1.58 mg./24 hours. Group III of persons examined consisted of 27 men and 52 women among the residents of the locality; Group IV consisted of school children, 63 boys, 50 girls. X-rays showed abnormalities in 4% of adults, none in children. No sign of injury to health, attributable to F was seen. The mean blood F values among men of group III were 2.55 ppm, 3.12 ppm for women; among boys of group IV,

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2.17 ppm, among girls, 2.24 ppm. The urinary values among group III were 0.84 mg./24 hours for men, 0.84 mg./24 hours for women; in group IV, 0.44 and 0.45 mg./24 hours for boys, 0.32 and 0.34 mg./24 hours for girls. No direct correlation could be established between the level of the blood or urinary F and the presence or absence of changes in bones.

IV. The dental condition of adults and school-children in the Fort William area. T.H.J. Douglas.

Dental examinations included 102 adults, of whom 72 were employed in the factory. The factory workers' mouths showed a great variety of dental conditions, such as might be seen in any industrial community, and there was nothing to suggest the influence of F compounds. The teeth of adult local residents were normal. Among 373 school children examined, 5.6% had "mottled teeth." However, a survey in Moray and Nairn (out-lying districts) showed 3.1 and 0.6% "mottling" among children. Evidence suggests that school children from Inverlochy (1 mi. from factory) may have had greater resistance to dental caries than either the Ft. William (1 1/2 mi. from factory) children, or the controls from the 55 schools elsewhere in Scotland. Drinking water F is low in the 2 communities (0.07-0.18 ppm). It is possible that the local children may have ingested traces of F after soiling hands with dusty objects, or inhaled excess F from atmosphere, but there is no positive evidence that Inverlochy children were more exposed to F's than those from Ft. William; in fact, the urinary values were very similar.

V. Physical properties of bone in fluorosis. G.H. Bell and J.B. de V. Weir.

Four sheep affected by fluorosis from Achintee, Ft. William and 3 controls selected on the basis of resemblance of general condition to that of affected sheep were subjected to mechanical, chemical and crystallographic tests. The affected ones were on the average about 25% stronger than the controls. Their average breaking stress was slightly higher (29,000 as against 27,300 lb./sq. in. for the controls). They were on the whole more flexible. On twisting, the strength was on the average the same as that of controls; the breaking stress on twisting, about 20% less than in controls. The ratio of breaking stress on twisting to that on bending (giving clue to strength of interconnections between the longitudinal fibers) tended to be less in the affected bones than in the controls. There was no appreciable difference in the average ash content of the affected femurs as compared to controls. The mean value for F in the bones was 1.02%, 0.023% of the ash, respectively. No differences were observed in crystallographic tests.

Appendix A: The toxicity of fluorine compounds, a review of the literature.

Appendix B: A description of analytical methods.

253 references.

56. Coal Producers Committee for Smoke Abatement: A Study of Smoke and Air Pollution in the Kanawha Valley. Cincinnati, Ohio, 1949, 78 pp.

An air pollution survey was conducted in the Kanawha River Valley around Charleston, W.Va., i.e., from Cabin Creek to and including Nitro. 29 large and small plants were inspected in that area. The relative concentrations of settled solids (sootfall) deposited in the area were measured at 12 separate locations in the valley for 24 hr. periods on Oct. 18, 19 and 20, 1949. These were compared with the quantitative results obtained by the W.Va. Dept. of Health, Bureau of Industrial Hygiene at 10 of these stations in the years 1945-47. These latter results are tabulated. The Oct.-Nov.-Dec. averages for 1949 were: 420 tons/sq. mi./yr. at Davis Creek; 560-Dunbar City Bldg.; 521-Spring St., So. Charleston;

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Coal Producers Committee for Smoke Abatement. (continued) 430-Park Ave., Charleston; 1737-So. Charleston City Bldg.; 576-Virginia St. E., Charleston; 856-State Capitol Bldg.; 647-Owens; 929-No. Charleston and 4137-Belle Lock 2. These values were, in general, comparable to the 1947 year averages. The major air pollutants were fly ash, smoke, metal fumes and dusts, coal dust, cinders, tar vapors, H_2S, gaseous Cl_2 derivatives, CS_2, N oxides and SO_2. From the inspections made of the larger plants in the valley it appeared that, in general, excellent progress had been made in the period since the close of World War II in abating air pollutants. Observations of the sources and extent of pollution in the valley were also made from the air. The reports of individual plants, of railroad operations and of the meteorological conditions are given.

57. Eisenbud, M., Wanta, R.C., Dustan, C., Steadman, L.T., Harris, W.B. and Wolf, B.S.: Non-occupational berylliosis. J. Ind. Hyg. Toxicol. 31:282-94, 1949.

Eleven persons showing chronic Be poisoning (berylliosis) have been reported among residents in the vicinity of a Be producing plant. None gave a history of occupational exposure to Be. Ten of the affected persons resided within 3/4 mile of the plant. The distribution of the cases of berylliosis with respect to the plant indicates that the incidence of disease was a function of the concentration to which the residents were exposed. The 11th patient resided almost 2 miles from the plant and was a member of the household of an employee of this Be plant. This patient's disease is believed to have resulted from atmospheric contamination introduced to the household by work clothes of the employee. Based on air analyses made during simulated home cleaning of work clothes, a daily laundering can result in the inhalation of 17 μg. of Be. An extensive air analysis program conducted in the vicinity of the plant yielded useful data on the levels of atmospheric contamination. The concentration at 3/4 mile is of particular interest because the lower concentrations beyond this distance have not produced known cases in the 7 years that this plant has been in active operation. It is estimated that the average concentration 3/4 mile from the plant during this period of time ranged from 0.01 - 0.1 $\mu g./m.^3$. The cases appear to have resulted from exposure prior to 1946, when the 3/4 mile concentration is estimated to have been approximately 0.1 $\mu g./m.^3$. The average daily concentrations of Be in the vicinity of a plant producing and processing Be should be limited to 0.01 $\mu g./m.^3$. There is no justification for applying these data as criteria in judging the hazard of exposed workers in the Be industry. The plant in question has had a comparatively low incidence of berylliosis, despite the relatively high exposure to atmospheric contamination within the plant. No satisfactory explanation can be given for this discrepancy, but the specific toxicity of the "neighborhood" contamination may be enhanced by smaller particle size than would be expected within the plant. The results of the air analyses, when related to the amount of effluent from this plant, are found to be in close agreement with the results of the theoretic methods of estimation proposed by Sutton and by Bosanquet and Pearson. (Author's summary.)

58. Ely, S.B., Supt.: Report on Railroad Smoke Condition, 1949. Pittsburgh Department of Public Health, Bureau of Smoke Prevention, 1949, 10 pp.

This is a report of the record of the work done by the Pittsburgh Bureau of Smoke Prevention, working with the cooperation of the railroad companies during the year 1949. A survey of the number of diesel and steam engines in use on each railroad line, a summary of the 1949 inspections, and samples of a tabulated monthly report of the bureau, of a railroad inspector's report, of a trial and of discipline given by road foreman of engines are included.

59. Lanza, A.J.: Health aspects of air pollution. Paper presented at the 42nd Annual Conference of the Smoke Prevention Association of America, Birmingham, Ala., May 24, 1949, 13 pp. Extract in Heating, Piping, Air Conditioning 21:123-5, 1949.

It is concluded that industrial fumes and gases do not occur in the general atmosphere to an extent to cause disability or death, except in very unusual and rare instances. The fumes and gases may constitute a nuisance and even, at times, irritation and inflammation of eyes and upper air passages. Smoke pollution, aside from its economic aspects, is a nuisance. It can seriously interfere with general well-being and comfort. But a brief review of some of the available statistics on the death rates from respiratory infections and cancer shows that it cannot be stated that smoke pollution can cause specific disease or death to any considerable degree.

The average rates/100,000 for cancer mortality of the respiratory system in New Orleans, St. Louis, New York, San Francisco, Cleveland, Philadelphia, Boston, Baltimore, Chicago, Washington, D.C., Los Angeles, Detroit and Pittsburgh for 1940-47 and for each of the individual years and for lung and bronchus cancer mortality for the same years for 11 of these cities (Chicago and Detroit excluded) are included.

60. Logan, W.P.D.: Fog and mortality. Lancet I:78, 1949.

A dense fog covered London and the surrounding country from Nov. 26-Dec. 1, 1948. An analysis of the death rates by weeks (nos. 44-51) in 1945, '46, '47 and '48 show 20-30% more deaths in the 48th week in 1948, the week of the fog, than in the 4 previous weeks, There were 1019 deaths as compared to an average of ca. 800 the weeks before. The effect continued into the 49th and 50th weeks. The deaths from 9 selected causes are also tabulated by week. Much of the increased mortality was due to respiratory infection, with registered deaths due to bronchitis and pneumonia more than doubled during the 48th week. There was also some increase in deaths from myocardial degeneration and cancer. The increased mortality was numerically greater for those aged 65+, 108 deaths from bronchitis as compared to 59 for the week before, but it was proportionately greater in those aged 45-64, 32 as compared to 8 for bronchitis. Deaths due to pneumonia, especially among the elderly, remained above normal during the next 2 weeks.

61. McCabe, L.C., Mader, P.P., McMahon, H.E., Hamming, W.J. and Chaney, A.L.: Industrial dusts and fumes in the Los Angeles area. Ind. Eng. Chem. 41:2486-93, 1949.

"Meteorological and topographical conditions in the Los Angeles basin cause the retention of dusts and fumes, frequently for several days. Eye irritation and limited visibility are characteristic of the resultant smog. Studies of the aerosols in this area have been undertaken by government and private laboratories. Methods and equipment used by the Los Angeles County Air Pollution Control District in identification of industrial contaminants are described. The roles of sulfuric acid mist and metallurgical dusts in smog formation are discussed," and the examination of submicron dusts is described and illustrated. The average monthly dustfall for several years are tabulated for the following cities: Los Angeles, Calif. (1946-48), Cincinnati, O. (1946-47), Rochester, N.Y. (1941-42), Chicago, Ill. (1946-47) and Detroit, Mich. (1945-46).

62. Magill, P.L.: The Los Angeles smog problem. Ind. Eng. Chem. 41:2476-86, 1949.

The most disagreeable aspect of smog to the Los Angeles public is eye irritation. The records do not show that the Los Angeles climate has

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changed in recent years, although the average visibility is now not as good as prior to 1944, which was about the time that the eye-irritating effect became most evident. The peculiar meteorological and topographical situation in the Los Angeles area which causes the formation of smog is discussed in detail. The method, by which the Stanford Research Institute's numerical smog index was determined from solely meteorological data, is explained; it has proved to be a reliable indicator of the presence of eye irritation in Los Angeles. From a correlation of smog with upper air pressures and surface air movements, smog and smog-free days may be forecast. CHOH, SO_3, SO_3 and CHOH, mixtures of aldehydes, C black and CHOH, CHOH/sea H_2O, SO_2, SO_2 and CHOH, acrolein, acrolein and C black, acrolein and CHOH, H_2S_n, and elemental S were tested with only the following giving any positive results. Acrolein may play a supporting role in eye irritation but it is not a chief offender. Hydrogen persulfide, H_2S_n, is highly irritating at concentrations as low as 0.2 ppm, although it did not produce the same effect as smog, but rather nausea and headache. Elemental S, vaporized and suddenly cooled in an air blast, produced irritated eyes at approximately 2.6 ppm; suspended as finely divided S, definite eye and nose sensations of a dry, feverish nature occur at concentrations as low as 0.2 ppm. However, tests on eye irritating days have failed to show the presence of elemental S. It is concluded either that the material responsible for the irritating effect has escaped collection and identification, or that certain combinations or forms of materials exist that have powerful synergistic actions with materials already known.

63. Schrenk, H.H., Heimann, H., Clayton, G.D., Gafafer, W.M. and Wexler, H.: Air Pollution in Donora, Pa. Public Health Bull. No. 306, Washington, D.C., Federal Security Agency, Public Health Service, Division of Industrial Hygiene, 1949, 173 pp.

Biological Studies

a. The Acute Episode

A representative community survey of 1/3 of the households of the Donora area on the ill effects of the smog was taken by 6 registered nurses from Dec. 2, '48 to Mar. 30, '49. Such information as personal data, occupational history, previous health status and health during the smog was gathered. Interviews of many persons ill from the smog were taken by physicians and the records included personal data, occupational history, onset and time of smog illness, symptoms noted, treatment received and allergic history.

On examining the Donora area as a whole, the following was found: population - 13,839 (51% male, 49% female and 8.5% non-white population for each sex); age distribution - 30% <20 yrs., 40% 20-44 yrs. and 30% ≧ 45 yrs.; occupational distribution - 35^{+}% gainfully employed, 35^{-}% housewives and 30% school and pre-school children.

42.7% of the total population experienced some affection from the smog with 15.5% mildly, 16.8% moderately and 10.4% severely affected. Sex, race and occupational differences in incidence rates were negligible. However, both total incidence and degree of severity of affection increased with age.

The onset of affection was greatest the 2nd day of the smog, reaching the highest numbers in the 6-hr. period of 6 p.m. to midnight Oct. 30th. About 60% of the onsets were sudden and the other 40% were gradual.

90% of the affected group reported upper respiratory symptoms, 87% - lower respiratory symptoms, 34% - gastrointestinal symptoms and 45% - "other" symptoms. Of the individual symptoms reported, coughing was the most frequent being reported by 1/3 of all persons in the area. Sore throat was the next most frequent for ages ≦ 45, while constriction of the chest was the 2nd most frequent for ages > 55 (both being equal in the age group 45-55). Some of the symptoms, particularly cough, persisted until the time of the survey, the

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tendency showing an increase with age.

For all ages, over 80% of disabling affections lasted one week or less, and the disability rates showed 8,457 days lost because of illness due to the smog.

Incidence of smog affection was higher, and in general more severe, for those with the following chronic diseases: 87.6% among persons with bronchial asthma, 77.2% among those with heart disease and 78.9% among those with chronic bronchitis.

The Donora area was divided into 12 residence districts (7 in Donora, 5 in Webster) for purposes of comparison. For persons of all ages, the incidence and degree of severity of all smog affection were higher for the Webster area than for the area as a whole, and it was found that althougn the onset of affection in Webster was similar to that in Donora for the 1st 2 days, it greatly increased in Webster by noon the 3rd day and thereafter.

Many tables and figures showing a detailed picture of statistics summarized above are given.

About 50 persons were hospitalized during the smog period. The records of 32 of these were obtainable and it was found that all these patients appeared to have in their clinical histories a component of cardiorespiratory disease. This and further examinations indicated these preexisting diseases to be significant factors in the occurrence of severe smog illness. The case histories of these 32 persons are given together with a selected group of X-rays.

The death rate for the area was 6 times the usual for the 7-day period of the fog. Of the 18 persons who died, 17 became ill by 8:30 p.m. Oct. 29th (18th - Oct. 30th) and 15 of these died on Oct. 30th, 2 on Nov. 1st, the 18th on Nov. 8th.

Autopsies could be performed on only 3 persons who had died during or immediately after the smog and on 2 more who had died some months later. These indicated that the fatal cases differed from the severely ill cases only in degree of severity and outcome and that the factors possibly influencing the fatal outcome were age, place of residence (Webster vs. Donora), color and previous health status. The factors which apparently did not influence death were sex, previous occupational status and duration of residence in the community. Death seems to have occurred in certain individuals who were more vulnerable to low levels of irritation by reason of a pre-existing chronic cardiovascular disease unrelated to the incident. Case descriptions of all the autopsies performed are given.

In an attempt to correlate the presence of pulmonary emphysema with the occurrence of illness during the smog, chest roentgenograms on both inspiration and expiration were taken on 116 adult, male workers who had been ill from the smog and on 105 who had not. The results indicated that emphysema did not play a significant role in the causation of symptoms due to smog exposure.

Studies of influenza antibody titer of the blood of 223 persons who had been ill during the smog and on 128 who had not showed that an influenza outbreak was probably not the cause of the illness occuring in the Donora disaster.

Enough data for the study of the relationship of a history of allergic manifestations to the incidence of smog illness was available only in cases of bronchial asthma (already discussed) and eosinophilia. The latter was not found to be significant.

Blood spectrophotometric studies on 114 blood specimens from persons ill during the smog showed no abnormal components (e.g., methemoglobin, sulfhemoglobin and COhemoglobin) that would indicate appreciable amounts of such contaminants in the air during the period studied.

A study of the smog effects on animals was made by a trained

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veterinarian. Data were gathered from visits to the households reporting illnesses in animals and to a random 1/5 of the farms in the surrounding area and from all other possible sources.

None of the animals in the charge of the local veterinarians, county agents, technicians of the dairy cattle breeding association, poultry dealers or slaughterhouse officials showed unusual incidence of illness during the smog. Also no significant drop in milk production among the dairy herds was recorded.

Dogs were most affected of all the animals (dog, cat, fowl, canary, rabbit and pigeon) examined. 38 out of 245 dogs became ill and of these 10 died. Symptoms were classified as "change in attitude" (36 cases), respiratory system symptoms and digestive system symptoms. The greatest % of dogs that died were younger than 1 yr. and older than 11 yrs. The data available were not adequate to rule out distemper, especially at that season of the yr., as a factor in contributing to the observed sickness and death rates in the younger dogs ($\leqq$ 1 yr.). The canine disease was in the main mild and transient in nature except in the fatal cases.

The clinical effects on cats were similar to those on the dogs, but the morbidity and mortality rates were considerably lower.

Two households of the 3 who kept fowl on the property reported any effect of the smog on the fowl. 4 farmers of the area reported much illness in their flocks with a combined mortality rate of 40%.

Only 1 out of 7 households where rabbits were kept reported rabbits ill. Of the 13 farms having dairy cattle, only 3 claimed that their cattle had been affected with cough during the smog.

The illnesses observed appeared to be a type of general debility with most of the symptoms apparently caused by an inhaled irritant material with respiratory infection following.

The houses of 1/6 of the families interviewed by the nurses (241 or 5.56% of the area) and 20 dwellings in which had lived persons deceased during or right after the smog were inspected as to deficiencies in facilities, maintenance and occupancy. In general, the housing conditions in the Donora area compared reasonably well with conditions in other urban areas of similar size in the U.S. 2/3 were rated as having good to excellent over-all conditions of housing, although conditions in Webster were less satisfactory than in the area as a whole. The % of dwellings rated "good to excellent" decreased with occurrence of increasing severity of affection (68% for no affection to 59% for severely affected), and only 30% of those in which death occurred rated this.

Therefore, there seems to be some relationship between severity of affection and certain of the characteristics of housing quality.

Detailed studies were made of the H_2O supply, sewage disposal, garbage disposal and milk and food sanitation, but no evidence was found that these factors could be linked to the acute episode in the Donora area.

b. Long-Term Effects

Oral examinations were made on 262 male adult steel workers who worked in sections known not to have aerosols present and on 375 male students (ages 12-20) from the Donora and Webster schools.

Chemical studies analyzing for F^- were made on samples of the communal drinking H_2O in Donora, on samples of H_2O from drilled wells, cisterns and springs in Webster, on human bone specimens of rib sections of 3 autopsied bodies of persons of long-time residence who died from the smog, and on urine samples from adults and jr. and sr. high-school students who had lived sometime in Donora. The veterinary also collected bone specimens of various domestic animals for F^- analysis.

No case of mottled enamel was observed among the 427 school children examined. In studying F^- as a caries inhibiting agent, it was found that compared with 4 cities in Ill. that had been similarly studied, Donora and

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Webster fell within the pattern of inverse variation of caries experience rate and the F^- content of the communal H_2O supplies.

The F^- analysis of 19 pooled specimens of urine showed no significant difference among the age groups, and indicated that Donora in comparison with 13 other areas could be considered F^- free. It was concluded, therefore, that there were very few other sources of F^- present besides the communal H_2O. The analysis of the F^- content of human rib bones and cattle bones indicates that the F^- intake by inhalation or ingestion of both was not sufficiently high to have caused skeletal storage in excess of the amount normal in F^- free areas.

The oral examination of 262 adult males and of 427 school children gave no evidence of exposure to excessive acid aerosol.

Studies of the frequency and type of disability occurring among residents of the Donora area was made in order to evaluate the health status of the community. The necessary data (name, race, age, date absence began, length and cause) could only be obtained from the mutual sick benefit associations of the 3 plants in the area and 2 other western Penn. steel companies for the 3-year period 1946-48.. The rates for sickness and nonindustrial injuries for each company for the total and individual years against the broad and individual causes were tabulated and showed insignificant differences. However, a distribution of such absences by year and month showed the effect of the smog in an unexpected rise of absences in Oct. '48 in the zinc and steel company, but not in the other 2 companies.

Data on mortality rates were obtained from photostats of all death certificates for the Borough of Donora for the period 1945-48. For a reliable population base on which to compute mortality rates, Pittsburgh, Pa. was chosen as a control.

Unusual weather periods, i.e., when severe smog conditions existed, occurred twice before 1948, in Oct. '23 and Oct. '38. During these periods there was no unusual increase in death rates with a random distribution of cause of death. In Apr. '45 a high increase of deaths occurred from cardiovascular diseases, but with no peak, during which time the weather conditions were most favorable for nocturnal retention of smoke.

The monthly mortality rates for Pittsburgh and Donora are compared, which showed that Donora followed the seasonal pattern of deaths for Pittsburgh and for the entire country except in Apr. '45 and Oct. '48. When mortality rates/100,000 were compared for Donora and Pittsburgh according to broad cause groups it was found that the Donora rate was generally lower than Pittsburgh's but no conclusions were reached.

By comparison with ratios for certain causes of death for the towns adjacent to Donora, it was found to have the most favorable ratio of the number of actual deaths to the expected number of deaths from specified causes of any of the 4 towns in Washington County. Also it was found that a marked increase in deaths occurred during the smog of Oct. '48 in Rostraver Township (including Webster) and Monessen and to a slight degree in Elizabeth or in those communities lying near Donora on the S and E of the Monongahela River rather than those on the N and W. These resembled those in Donora with respect to age and cause.

Atmospheric Studies

a. Investigation of Atmospheric Contaminants

Plant effluents were analyzed for total particulate matter (PM), Pb, Cd, Zn, Fe, Cl, F, As, SO_2, total S, CO_2, CO and O_2 in all the stacks, while oxides of N, acid gases, H_2, AsH_3, SbH_3, Mn and $Fe(CO)_6$ were analyzed for in only the appropriate stacks. Nonindustrial effluents were analyzed for CO_2, CO, O_2, S, Cl and F. The collection methods and apparatus used are described in detail.

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Samples of the general atmosphere were collected at 12 sampling stations located throughout the area. Wind direction and speed, temperature, humidity, light readings, general weather and smoke behavior were recorded as well as the chemical analyses. The samples were analyzed for SO_2, total S, Cl, F, total PM, Zn, Pb, Cd, oxides of N, CO and H_2S.

The methods for the determination of the contaminants are detailed.

A description of the zinc and steel plants including the operations carried out in each department was given in detail. Cottrell precipitators (and similar equipment) were in operation and collected a good deal of the dust and fumes given off in the effluent gases, but much of it also escaped into the atmosphere along with the other gases.

Since certain plant operational changes took place after the smog, the plants reverted in stages to the same operational procedures and production rates as before in order to obtain for the survey the necessary data on the contaminants that had been given off. From Jan. to Mar. 24 was designated the period of "curtailed production," from Mar. 24 to Apr. 17 - the "transition period" and from Apr. 17 to 21 - the "test period." Samples were mostly taken during the period of "curtailed production" and the "test period."

The results of the analyses of samples collected from each department in the zinc and steel plants are tabulated.

At the roasters, samples were collected and analyzed for SO_2, total S, Cl^- (no trace), F^- (no trace), As (trace) and total particulate matter, and the results indicated that the contribution of the roasters to the general atmospheric pollution of the valley was not significant.

The estimated total atmospheric pollution load/24 hrs. from the sinter plant exhaust stacks is given below and shows that the sinter plant is a significant contributor to the atmospheric pollution load.

The estimated lbs./day of contaminants discharged into the atmosphere from the 9 Zn spelter stacks are shown below. Particulate matter, CO and CO_2 are considered as major contributors to the general atmospheric pollution load.

The estimated lbs./day of contaminants from the 9 waste heat boilers, given below, shows that the amount of particulate matter and SO_2 discharged from these stacks is another major contributor to air pollution.

The estimate of lbs. of contaminants/day from the Waelz plant shows that it does not materially contribute to the general air pollution load.

The airflow through the roof louvers in the Zn dross plant was obviously small and, therefore, the total contamination from this plant was negligible. The results of the analyses gave: total PM - 40.5 mg./m.^{3}; Zn - 18.5 mg./m.^{3}; Pb - 7.1 mg./m.^{3}; Cd - 0.005 mg./m.^{3}; total S - 0.9 mg./m.^{3} and Cl, F and As - 10.4, 0.0 and 0.015 mg./m.^{3}, respectively.

The averaged results of the inconstant rate of discharge of contaminants from the 6 stacks of the acid plant (with a total airflow of 43,000,000 ft.^{3}/day) are:

Constituent	Test period	Curtailed production
Total sulfur as S (lbs.)	2,500	1,400
Oxides of N	8,500	6,100

This is the main source of discharge of oxides of N into the air.

The estimated lbs. of contaminants/day (with a charging period of 1/2 hr. and a normal operation of 23 1/2 hrs.) from the Cd plant stacks, given below, shows its contribution to air pollution is insignificant.

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The estimated lbs. of contaminants/day for each department

Constituent (lbs./day	Sinter Plant	Zinc Spelters Test period	Zinc Spelters Curtailed prod.	Waste Heat Boilers Test period	Waste Heat Boilers Curtailed prod.	Waelz Plant	Cd Plant
Total PM	2,900	42,500	20,800	21,600	8,300	10.0	13
Zinc	250	24,000	12,200	5,200	1,500	3.0	0.3
Lead	250	100	100	50	20	0.6	0.1
Cadmium	100	220	100	2	0.5	0.1	10.0
Chlorine	400	5,000	1,850	410	410	10.0	0.2
Fluorine	3	trace	0	15	15	0.6	0.03
Arsenic	*	4	4	5	-----	0.0	0.007
Sulfur	-----	2,300	900	2,800	2,800	----	0.05
Total S(as SO_2)	17,000	-----	-----	-----	-----	400	---
SO_2	-----	560	560	34,000	34,000	----	----
CO	8,100	54,400	54,400	1,700	1,700	----	----
CO_2	120,000	600,000	600,000	-----			
Vol. Airflow (million $ft.^3$/day)	86.4	5000.		600		13.	2.5

*0.4-particulate As; 0.7- gaseous As

For the steel plant, samples were collected inside the blast furnace building at the floor level and on the catwalks. The PM consisted of Fe (mainly), and also S, Cl⁻ and Mn. CO varied from 40-100 ppm below to 20-500 ppm on the catwalks (near the blowoff valves). These results were not used to estimate the lbs. of contaminants/day because these contaminants were present in the open areas and did not emanate from stacks.

The estimated lbs. of contaminants/day for steel plant

Constituent (lbs./day)	Blast furnace: blast furnace gas	Blast furnace: stove stacks	Blast furnace: sinter plant stacks	Open Hearth: open hearth stacks
Total PM	3,600	70	1,550	2,100
Iron	1,800	10	700	600
Lead	-----	-----	-----	100
Manganese	-----	1.4	-----	-----
Chlorine	19	57	40	0
Fluorine	0.7	2	2	39
Total S	-----	80	1,050	5
SO_2	-----	10	190	-----
CO	635,000	34,000	27,000	600
Vol. Airflow (million $ft.^3$/day)	*32	250	140	374,400

*Amount wasted and leakage/day

This shows that for the blast furnace department significant amounts of particulate matter (mainly Fe oxide) and CO from the blast furnace gas, of CO from the stove stacks, and of particulate matter, total S, SO_2 and CO from the sinter plant stacks contributed to the general air pollution load.

The major contribution of the open hearth stacks to air pollution is particulate matter, as seen above.

The blooming mill stacks contributed very little to the air pollution load giving off 18 lbs. of oxides of N/day and 156 lbs. Fe carbonyl/day. Neither did the wire mill stacks contribute significantly which gave off

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28.5 ppm acid gases (in terms of HCl) from the acid cleaning bath and 100 lbs. total PM, 24 lbs. Zn and 24 lbs. Cl/16 hrs. from the nail galvanizing stack. (Total volume of airflow was 8,000,000 ft.^{3}/16 hrs.)

Coal, natural gas, blast furnace gas and fuel oil are all used as fuels in the zinc and steel plants. The results of analyses of samples collected in the steam generating boiler stacks are shown and the lbs. PM given off/day are estimated as:

Location and description of operation	Volume of flue gas (millions ft.^{3}/day)	Total PM	Fe	Total sulfur as S	Cl	F
Blast furnace boilers (16 stacks - blast furnace gas, coal and oil)	650	12,200	5,800	550	375	75
Blooming mill boilers (13 stacks - coal and coke)	480	1,900	----	8,200	0	4
Wire mill boilers (11 stacks-coal)	450	1,900	----	7,700	0	4
Zinc plant waste heat boilers (9 stacks in operation - coal)	600	21,600	----	19,800	410	15
Total------------------------		37,600	5,800	36,250	785	98

Coal is used extensively for heating in Donora, and gas and electricity for cooking. 2/3 of the boats passing Donora are coal-burning steamboats. 18 freight and 6 passenger coal-burning steam engines pass through Donora daily while 10 switch engines operate continuously in the area. 3,000 automobiles were estimated to be in Donora.

The total estimate of lbs. of contaminants/day given off from all these sources is:

Source	Total PM	SO_2	CO_2	CO	Cl	F	Volume of exhaust gas (ft.^{3}/day)
Domestic	12,600	12,600	1,400,000	74,000	15	30	95,000,000
Steamboats	660	600	74,000	370	1.5	0.8	9,500,000
Trains:							
Through	200	200	22,000	300	0.2	0.1	1,300,000
Local	3,000	3,000	350,000	4,700	3.0	1.5	20,000,000
Automobiles	----	----	70,000	30,000	---	---	5,760,000

Twelve air sampling stations were set up throughout the area near the temporary U.S. Weather Bureau stations. Their location in relation to Donora and the plants and the surrounding circumstances are given in detail.

The distribution of the concentrations of 6 different atmospheric constituents (SO_2, total S, total PM, Zn, Pb and Cd) found at the 12 air sampling stations from Feb. 16 - Apr. 27, '49 is shown. All 6 constituents are grouped very markedly in the lower concentration ranges with only a small proportion in the higher ranges.

The distribution of atmospheric constituents found in the Donora area from Feb. 16 ' Apr. 27, '49 according to 5 date periods is given. There was a progressive increase in the amounts of contaminants in the air as production increased with a peak in period 4 (Apr. 18-21). The contaminants in relation to time periods of the day (4) were also examined. It was found that for SO_2, total S, total PM and Pb the highest concentrations were noted in the night period, especially the period of 6:01 p.m. to midnight, and this was considered to be due to greater air stability at night. Zn and Cd showed similar patterns but with an increase of higher concentrations in the later morning (6:01 a.m. - noon), showing the influence of plant operations on the concentrations of contaminants in the general atmosphere.

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When the average ratios of concentration for these 6 contaminants are arranged in decreasing order by stations, it was found that the one in downtown Webster had the highest average concentration of the 12.

90% of the Cl values and 95% of the F values were in the lowest concentration ranges, 0.00-0.09 and 0.000-0.009, respectively. Similarly the concentrations of the oxides of N were found to be of a very low order of magnitude. Qualitative tests were also made for CO_2, CO and H_2S, but no positive results were obtained.

The Thomas Recorder indicated the concentrations of SO_2, SO_3, soluble salts and oxides of N to be highest around station 4 (downtown Webster) with NW winds above 10 mph.

Samples of particulate matter were obtained from 5 home filters in the Donora area and 1 from Monessen. One had been cleaned just prior to the Oct. smog and was obtained immediately after the smog, 3 covered a period before, during and after the smog, and 2 covered a period after the smog (1 of these from Monessen). A spectrographic analysis showed Si, Fe, Zn, Mg and Al to be major constituents, and Cu, Pb, Mn, Ca and Cd and others to be minor constituents. There appeared no significant differences in composition of the various samples for these materials as well as for NO_3^-, Cl^- and F^- for which chemical analyses were run. However, S varied significantly, showing the largest % for the sample collected during the smog, the smallest % for those collected after the smog and an intermediate value for those covering before, during and after the smog. Further data were needed to reach a definite conclusion.

A few air samples were taken outside the Donora area in Charleroi, Monessen and Monongahela City to compare the amounts of contaminants in communities adjacent to Donora, but the number of samples was not large enough to permit a comparison with the samples collected in Donora.

b. Meteorological Investigation

Donora is situated on the W slope (Webster on the E) of the relatively deep and narrow valley of the Monongahela River, ca. 26 mi. S-SE of Pittsburgh. The river meanders in a horseshoe pattern around Donora with the ends lying in the E-W direction. The general hilltop level (1,250-1,300 ft. alt.) rises rather steeply 450-500 ft. above the river.

8 major automatically recording weather stations, which recorded wind direction and speed, temperature, relative humidity and rainfall, were set up at strategic points in the valley to determine the micrometeorology of the Monongahela River valley at Donora. The results of this investigation and a detailed description of the meteorological conditions at Donora at the time of the smog were presented, and the following conclusions were drawn.

A. Micrometeorology of the valley for the period Feb. 14 - Apr. 28, '49:

1. Smoky periods were caused by the occurrence of strong atmospheric stability and stagnation of the air in the valley as well as some thousands of feet above the valley.
2. Anticyclones of polar origin often accompanied these conditions of strong stability and calm or light winds through a great depth of the atmosphere.
3. Stagnation alone did not cause an accumulation of smoke in the valley as was demonstrated by nonsmoky periods with light to calm winds. These periods occurred when fresh, unstable polar air, behind a vigorously moving cold front, lay over the area.
4. Stability alone did not cause an accumulation of smoke. During windy periods with stable atmospheric conditions above the hilltop level, smoke was carried out of the valley.
5. Midvalley height stations on the E side of the valley all indicated flow parallel to the valley orientation at times of very stable conditions when the drainage current was deep enough to reach them, and down slope flow at other times when the main valley drainage current was more shallow

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and only the valley-side drainage flow affected the stations.
6. During the periods of very stable conditions the main valley drainage current in the lower portion of the valley came from down river.
7. Due to the turbulence of gravity currents operating all night on very stable nights, smoke, as determined by morning visual observations, apparently was evenly distributed throughout the valley longitudinally, laterally and vertically.
8. During the moderate to strong winds, turning effects within the valley were imposed upon the hill top wind direction; wind speeds in the valley along the valley sides were decreased in proportion to the depth in the valley and were lower on the lee side than the windward side. The decrease of speed with depth along the valley sides was greater for cross valley flow than for flow parallel to the valley.

B. Meteorology of the smog episode of Oct. 25-31, '48:
1. The Donora smog episode of Oct. 25-31, '48, was an extreme case of the "smoky morning" type described in this paper.
2. Willett, in examining weather records for the past 30 years, has shown that occurrences of meteorological conditions similar to those at Donora in late Oct. '48, may be expected on the average once in every 10 or 15 years with no guarantee that they would not occur in consecutive years or months or twice in the same month. Other notable stagnant meteorological periods occurred in Oct. 5-13, 1924 and Oct. 7-18, 1938.
3. Dense fog in the valley persisted past midday for 4 consecutive days, which maintained a high albedo during the period, and prevented heating of the valley floor.
4. Wind speeds remained less than 7 mph from the surface to 5,000 ft. for a period of 3 consecutive days, showing that the atmosphere lacked the ability to remove contaminants rapidly.
5. Four-day presence of maximum temperatures at Donora below those at the Pittsburgh airport shows the persistence of extreme valley stability for 4 consecutive days.
6. An extensive high pressure area covered the eastern United States and persisted over the Appalachian region.

C. General requirements for recurrence of smog conditions:
1. Pollution--Sources must be near and active.
2. Topography--Terrain favorable for the low-level trapping of air indicates potentially dangerous areas.
3. Humidity--Moisture in the lowest layers should be such that fogs can form and persist and so reflect the sunlight which might otherwise destroy the inversion.
4. Meteorological Model--A polar anticyclone, reinforced by upper air anticyclogenesis, appears to be the meteorological model most likely to produce the stagnant conditions required for the great pollution concentrations.
5. Season--Oct., apparently, is the month with the highest probability of occurrences of intense atmospheric stability and stagnation in the area of Donora.

c. Meteorological Conditions and Atmospheric Contaminants

The average concentrations of SO_2, total S, total PM and Zn are graphed by station and wind direction. Most of the winds came from the S, SW, W and NW and, therefore, the stations N, NE, E and SE from the plants showed the highest average concentrations of the contaminants.

When compared with wind speeds, the concentrations of the various contaminants were lowest for 4-9 mph, and in general highest for 0-3 mph, and also high concentrations for 10-22 mph were recorded.

No definite trends or relationship between concentration and temperature or relative humidity ranges could be observed.

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The relation of contaminants to atmospheric stability is illustrated in the results of the analyses of air samples collected during a temperature inversion from 8 p.m. April 20 - 9 a.m. April 21, '49 (visibility ≦ 4 city blocks). These show a greater concentration of contaminants present during inversion, than during no inversion, as seen below.

	SO_2 (ppm)	Total S as SO_2 (ppm)	Total PM (mg./m.^{3})	Zn (mg./m.^{3})	Pb (mg./m.^{3})	Cd (mg./m.^{3})
Averages during inversion	.32	.52	2.634	.1461	.0134	.0043
Averages omitting inversion ("test period")	.12	.21	1.195	.0925	.0073	.0024

The graph of the variation of the stability factor and observed values of SO_2 and total PM against time showed that the values for SO_2 and total PM increased during the stable period and decreased rapidly when the stability factor decreased. When concentration values of the total PM were plotted against the stability factor, a definite grouping of low concentrations for unstable atmospheric conditions and of high concentrations for stable valley conditions was noted.

Discussion of Cause of Episode

None of the irritating contaminants detected were present in the air in a large enough concentration of itself to cause the syndrome (irritation of the respiratory system), but a combination or summation of the action of 2 or more contaminants probably caused this observed syndrome. SO_2 and its oxidation products and particulate matter were considered the significant contaminants.

Summary and Recommendations

A good summary of the biological and atmospheric studies was given and 10 recommendations were made. In substance, these recommendations were (1) to reduce, as far as possible, the amounts of the significant contaminants discharged into the air from the 2 plants, and (2) to establish a program of weather forecasts, whereby the approach of such conditions that cause prolonged smog can be forecasted so that the production of the industries in Donora and in the surrounding area can be curtailed in sufficient proportion to prevent the smog.

Why is October the Optimum Month for Smog at Donora -- Appendix III

This is so because during Oct. all 5 dynamic conditions necessary for a deep warm anticyclone to form and persist over the Donora area are best fulfilled. During this month, Donora lies on the southern edge of the westerlies; has a large enough cyclonic curvature (lateral wind shear) of the lateral wind-profile; maximum speed of the westerlies is not too great so that the cyclone may persist; there is a frequent and moderately developed shielding layer and there are favorable radiation conditions.

64. Schueneman, J.J.: A Report on Activities and Observations Concerning Atmospheric Pollution in the City of St. Louis. Ind. Hyg. Section, Division of Health, City of St. Louis, July 1, 1949, 10 pp.

The history of atmospheric pollution control in St. Louis and the provisions under the smoke regulation ordinance (1940) and air pollution ordinance (1948) are reviewed. Various surveys by outside agencies for particular types of pollution were made. An investigation of SO_2 concentrations in the air over St. Louis and East St. Louis was made in 1936-37. During the winter (Oct.'36-Apr.'37), the maximum concentration found was 2.266 ppm, the average concentration over the entire metropolitan area was 0.18 ppm and the average over the central district (5 mi. radius) was 0.256 ppm. In the summer (Apr.'37-Oct.'37), the

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maximum concentration was 1.090 ppm, the average over the entire area-0.060 and that over the central district-0.119 ppm. In 1939-40 and in June 1946 dustfall studies and in July 1948 and Jan. 1949 surveys of suspended and settled matter were made. Pollen studies done in 1929-35 and 1937-39 revealed that the ragweed pollen counts were among the highest of those found in 32 large cities. CO concentrations found in downtown city streets in 1936 and '37 were high for relatively short periods at traffic rush hours, otherwise not serious. In Oct. 1946 a city-wide survey of settled dust gave results of 6.5-18.0% fly ash with an average of 10.6 and a median of 10.0% for the 18 stations. The records of the U.S. Weather Bureau for smoke, fog and smog show a 73% reduction of smoke in the 5 years following 1939-40. Also included in the discussion is a brief description of the types of pollution from different industries, of the methods of determination, standards, methods of control, procedure for securing abatement and the difficulties encountered.

65. Shilen, J.: The Donora disaster. Ind. Med. 18:70-2, 1949.
For abstract see the first part of Shilen, J., Mellor, J.F., Stang, A.M., Sharrah, J.S. and Robson, C.D.: The Donora Smog Disaster. Pennsylvania Department of Health, Bureau of Industrial Hygiene, Mimeographed Report, (Oct. 1949?), 11 pp. The SO_2 concentrations found on Sunday, Oct. 31, 1948, are discussed and the mortality data are compared with those of 1947.

66. Shilen, J., Mellor, J.F., Stang, A.M., Sharrah, J.S. and Robson, C.D.: The Donora Smog Disaster. Pennsylvania Department of Health, Bureau of Industrial Hygiene, Mimeographed Report, (Oct. 1949?), 11 pp.
An investigation of the Donora smog catastrophe carried out by the Penn. Dept. of Health, Bur. of Ind. Hyg. was begun with air sampling on Sunday morning, Oct. 31, 1948, before and during the lifting of the fog which showed SO_2 decreasing in concentration from 0.54 to 0.08 ppm. Since the meteorological conditions were changing at this time it is believed that considerably higher concentrations of SO_2 existed on Oct. 29 and 30, 1948. Sampling stations were set up along the Monongahela River from Monongahela to Monessen after the fog and the samples analyzed for SO_2, soluble $SO_4^=$'s, F^-'s, CO, N oxides, H_2F_2 and weight of solids. SO_2 ranged 0.00-0.75 ppm, average - 0.17, and solids ranged 0.00-7.6 mg./m.^{3}, average - 1.82. Concentrations of the others were negligible. The over-all annual mortality rate for Donora residents was not significantly different for 1948 when compared with the annual mortality rate for Donora residents for 1947. The number of deaths due to heart disease for both years were numerically equal although there were 9 deaths due to respiratory causes in 1948 as compared with 6 deaths from the same cause in 1947. Of the 12 deaths among Donora residents which occurred on Oct. 30 and 31, 1948, 9 of the deceased had history of asthma. A spot check of the dental health of children in the Donora area did not indicate mottling of the dental enamel from reported fluoride exposures. An X-ray survey did not indicate any evidence of chronic pneumonitis. The weather situation at the time, which was a definite, contributing factor in precipitating the disaster, is thoroughly discussed. The topography around Donora, also a contributing factor, is reviewed. The new Division of Air Pollution Control will continue studies of the problems of air pollution and try to effect corrections.

67. Versluys, J.J.: Cancer and occupation in the Netherlands. Brit. J. Cancer 3:161-85, 1949.
A detailed, tabulated analysis of the death rates for all types of cancer in the Netherlands for 1931-35 is given. Lung cancer occurred in 1,291 or 5.54% of the men and in 369 or 1.42% of the women. In big towns, the % distribution of lung and mediastinum carcinoma was 4.7% as compared to 2.7 in the rural areas. The recorded and expected deaths from carcinoma by site

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Versluys, J.J. (continued)
among men of various trades and professions are given in great detail. No conclusions were drawn from the tabulated data in the paper.

68. Bourne, H.G., Jr. and Rushin, W.R.: Atmospheric pollution in the vicinity of a chromate plant. Ind. Med. Surg. 19:568-9, 1950.

Samples of the atmosphere were collected at distances varying from 100-10,000 ft. downwind from a chromate plant (location not stated) which discharged dust and mist containing chromite, Na_2CrO_4 and $Na_2Cr_2O_7$ through 12 stacks ranging 62-78 ft. in height. The samples were obtained during daylight hours and fair weather from June 1-Dec. 16, 1949. The mean leeward concentrations are graphed according to distance from the source. The concentration decreased gradually from 0.12 mg./m.^{3} at 100 ft.-0.06 mg./m.^{3} at 2000 ft. and then dropped rapidly to 0.001 mg./m.^{3} at 10,000 ft., which value approached that of the blanks. Orthogonal deviation of the sample apparatus from the cloud axis and non-measurement of strength of source, wind velocity and cloud diffusion, and hence no correction for the effects of these variables, impose some limitations on the value of these results.

69. Cadle, R.D., Rubin, S., Glassbrook, C.I. and Magill, P.L.: Identification of particles in Los Angeles smog by optical and electron microscopy. Arch. Ind. Hyg. and Occupational Med. 2:698-715, 1950.

The techniques of optical and electron microscopy are discussed with respect to collection of particles and identification of particles by chemical and physical means. The so-called chemical micrurgic technique in optical microscopy is described in particular. Such oxidizing substances as NO_3^-'s, H_2O_2 and organic peroxides, hydrocarbons, acidic material and crystalline material were identified by this method in material collected during smog in Los Angeles. Not all were present in every smog. The crystalline material contained NH_4^+ ions, $SO_4^=$ ions and F^- ions and possibly schairerite ($Na_2SO_4 \cdot Na[F, Cl]$) or pachnolite ($NaF \cdot CaF_2 \cdot AlF_3 \cdot H_2O$). The electron microscope can resolve much smaller particles than the optical microscope and also has a much greater depth of focus. However, it reveals only the physical form of the particles.

70. Chesner, C.: Chronic pulmonary granulomatosis in residents of a community near a beryllium plant: three autopsied cases. Ann. Internal Med. 32: 1028-48, 1950.

Three autopsied cases of chronic pulmonary granulomatosis occurring in residents near a Be plant are recorded in detail. Occupational histories on 4 worker and 4 "neighbor" nonfatal cases in this community are presented. A low incidence, spotty distribution and lack of relationship of the severity of the disease to the degree of exposure were characteristic. The onset of the disease in the worker cases was delayed for periods of 27 months to 4 1/2 years after the last exposure. Sputum studies and other laboratory examinations were essentially negative. The history, clinical picture and roentgen-ray studies were fairly characteristic. The chief autopsy findings were confined to the lungs. The microscopic sections showed a diffuse replacement of the lung parenchyma by a nodular and diffuse granulomatous lesion. The focal areas were always prominent. Granulomatous lesions were always present in the hilar lymph nodes and less frequently in the liver and spleen. The patients died of pulmonary insufficiency with right-sided heart failure. Be was recovered from the tissues in Cases 2 and 3. Spectographic analysis of the lung ash in Case 1 revealed the presence of Be. At the present stage of our knowledge, the recovery of Be in the tissues would only indicate that the individual had

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inhaled Be during life. This finding would tend to support a diagnosis of chronic berylliosis if warranted by the autopsy findings. Be analysis should be done on autopsy material from this area on individuals with no history of chronic pulmonary granulomatosis. This might help in determination of the relationship between exposure and the finding of Be in the tissue and disease. (From author's summary.)

71. Cholak, J., Schafer, L.J. and Hoffer, R.F.: Collection and analysis of solids in urban atmospheres. Arch. Ind. Hyg. and Occupational Med. 2:443-53, 1950.

The methods and equipment which have been used in an investigation, extending for a period of 4 years, of atmospheric conditions in Cincinnati with respect to certain solid constituents are described. Samples of settled dust and large unaltered samples collected dynamically were obtained each mo. at > 20 stations; a variety of gaseous pollutants were included in the determinations. Daily dust samples were also collected at many stations. The following results are reported. The 3-yr. average dust fall in 4 areas was: suburb removed from industry--12.0 tons/sq.mi./mo.; industrial area in basin of city--143; business area in basin--94 and area leeward of basin (hilltop)--34. Seasonal variations in settled dust and combustible material showed, in general, greater pollution in the 4 areas during the cold mo. than during the cool and warm mo. The 3-yr. average of the quantities and constituents of samples of dust collected by electrostatic precipitation in residential and semiresidential areas, in business and industrial areas and in control areas are tabulated. The seasonal variations in the business and industrial areas are also given; again pollution was highest in the cold mo., except for Pb and Mn.

72. Ely, S.B., Supt.: 1949 Report on Stationary Stacks. Pittsburgh Department of Public Health, Bureau of Smoke Prevention, 1950, 13 pp.

This is a report on air pollution in Pittsburgh in 1949 and on the work of the Bureau of Smoke Prevention in reducing it. It includes reports on dustfall records, dust analysis, "smoke observations" or visibility measurements, the work of the Bureau in "controlling illegal coal" and enforcing the law's other provisions and comments from aviators on the great improvement in visibility above Pittsburgh. Estimates by various methods indicate that there was a 40 - 75% reduction in dirt in the city. Dustfall records showed a reduction of 79.0 - 61.6 tons/sq.mi. over downtown Pittsburgh, and reductions at nearly all the other points where measurements were taken. This dust came from other sources besides smoke. About 60% of its composition was SiO_2, Fe_2O_3, ZnO and SO_3. The amount of smoke, as judged by visibility, increased slightly from 1948-49, with a steady loss from 1945-48, but the smoke during the heating season decreased constantly. Statistics on complaints, cases tried and improvements in private stacks are included. (Ind. Hyg. Dig. 14:520, 1950)

73. Gärtner, H. and Jötten, K.W.: (Investigation of health hazards from generator gases and waste gas from generator-gas motors.) Gesundh. Ing. 71:294-8, 1950.

The differences in specific combustible material for a generator produce variations in performance during operation. From a health standpoint no definite conclusions were drawn. Generator gas can be regarded as a health hazard. Stress was placed on CO_2, and chronic damage was mentioned as important. Data are presented on the O_2, CO and CO_2 content of generator gas from wood, anthracite, peat and lignite. (CA 45:1750, 1951.)

74. Largent, E.J.: Effects of fluorides on man and animals. Proc. 1st Natl. Air Pollution Symposium, Pasadena, Calif., Nov. 10, 11, 1949:129-34, 1950.

A brief description is given of bone changes seen in cows from a herd grazing in a pasture adjoining a factory which emitted from its stacks a F-containing dust. F concentrations were determined in samples of milk, blood and excreta collected periodically from one cow after it arrived in Cincinnati, and in tissues after slaughter. The source of F was identified, for practical purposes, by sampling the vegetation in the pasture near the factory and the atmosphere overlying the pasture. The F content of samples of grass was about 300 ppm. The concentrations in vegetation decreased as the site of collection was moved away from the factory stacks. The air samples contained in their gaseous portions <1ppm (0-0.029 ppm), while 4.3 ppm or particulate F was found (total F, including dust) in one sample, the other concentrations ranging from 0-0.173 ppm. X-ray diffraction patterns showed this to be rock phosphate, the particles decreasing in size with distance from the factory. Although bone changes developed in cows, no difficulties of this type were reported as occurring among horses or swine. The reason is that food eaten by a cow may remain in the gastroenteric tract for a longer period of time than would be required for its passage through the digestive tract of horses. Thus, difficultly soluble F would have more opportunity to dissolve and be absorbed into the blood stream of cows. This problem does not extend to man since he eats much smaller quantities of leaves, few of which are consumed without being washed; the alimentary emptying time is comparatively short, thereby reducing the extent of alimentary absorption of F.

F concentrations found in the atmosphere in and around factories in Denmark, England and the U.S.A., as well as the effects of known concentrations of H_2F_2 upon experimental animals are discussed in relation to their effects upon man. The most extensive data available at present concerning the metabolism of F have been obtained in the study of experimental subjects to whom various compounds have been administered orally. In view of the F concentrations reported so far in samples collected in the open air, there seems to be little or no possibility of injury to the residents of typical industrial communities. Even if small amounts of F were present in the atmosphere, these would be unlikely to produce chronic effects equal to those observed among people who ingest high levels of fluoride in their drinking water.

75. Leonard, A.G.G., Crowley, C. and Belton, J.: Atmospheric pollution in Dublin during the years 1944 to 1950. Sci. Proc. Roy. Dublin Soc. (N.S.) 25: 166-7, 1950.

Air pollution due to suspended matter is graphically compared with deaths due to respiratory diseases from 1938-49 in Dublin. The results show no direct relationship between the 2 in Dublin city, though earlier work during 1938-41 appeared to show such a relationship. SO_2 concentrations at Leinster Lawn, Dublin and the Albert Farm, Glasnevin are given from 1938-42 and 1944-49. As in the case of suspended matter, pollution by SO_2 in both city and neighboring country fell noticeably in 1941, when peat was being burned instead of coal, and continued at a low level till 1947, when coal again became available.

76. Schueneman, J.J.: Atmospheric concentration of sulfur dioxide in St. Louis, 1950. Am. Ind. Hyg. Assoc. Quart. 12:30-6, 1950.

A survey of SO_2 concentrations in St. Louis was made by the health authorities in Feb. and Mar. (winter) and in June and July (summer), 1950 and the results compared with those of the 1936-37 survey made by the Air Hygiene Foundation of America, Inc. (now the Industrial Hygiene Foundation) in order to determine how much improvement has been made by the smoke regulation program. Samples were collected on all days of the week

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Schueneman, J.J. (continued)
and at all hours of the day on 27 different days at 9 locations during the winter, and on 21 different days at 14 locations in the summer; the locations were similar to those in the 1936-37 study and gave good geographical coverage. The results of the 2 surveys are compared by station for summer and winter. Average concentrations for all stations in winter were 0.041 in 1950 and 0.239 ppm in 1936-37 and in summer were 0.030 in 1950 and 0.110 ppm in 1936-37. This shows an average reduction of 83% in the winter and 73% in summer, which has probably been brought about by enforcement of smoke regulating ordinances and by increased use of oil and gas as fuel. Higher average concentrations were found in and near downtown in both surveys. Concentrations now found in the downtown portion of the city are comparable to those which were found 1-20 mi. outside the city, 13-14 years ago. Results apparent to the public include lack of "sulfury sensation" in the city air, better keeping of paint, less surface deterioration of stone and metals and better plant life. The diurnal variations in summer and winter are compared graphically for both surveys; however, there are too little data in the 1950 study to support reliable trends. During the winter 1950, SO_2 concentrations averaged 0.054 ppm for winds <13 mph and 0.027 for winds >13 mph; there was no significant correlation in the summer. In 1950, highest average concentrations occurred with E winds, and in both studies, in general, higher average concentrations were found in the city when winds were blowing from the directions of extensively developed areas surrounding the city. During the summer, average SO_2 concentrations were significantly higher, when the Weather Bureau did not note smoke than when they did; correlation in winter was not significant. During the winter 1950 study, it was found that average SO_2 concentrations tended to increase as visibility in miles decreased. During the summer 1950 study, visibility observations did not correlate with SO_2 concentrations. These observations on smoke and visibility were made from only 1 point downtown and, therefore, the correlations may not be true for all parts of the city.

77. Steiner, P.E., Butt, E.M. and Edmonson, H.A.: Pulmonary carcinoma revealed at necropsy, with reference to increasing incidence in the Los Angeles County hospital. J. Natl. Cancer Inst. 11:497-510, 1950.

In necropsies performed from 1918-1949 at the Los Angeles County Hospital, carcinoma of the lung ranked 4th, or 8.4%, among malignant tumors, and in 1 recent 4-year period (1943-46), it was 1st. The incidence of this tumor showed a progressive increase by 5-yr. periods. The increase was more than 4-fold in relation to all necropsies, 3-fold to all cancers and 4-fold to hospital admissions. 4 other types of common tumors, used as controls, viz., carcinomas of the stomach, large intestine and pancreas, and intracranial tumors, did not show a similar increase. The increase was not explained by change in sex ratio or age of persons subjected to necropsy, by increased skill in diagnosis or changes in classification by pathologists, or by immigration, hospital admission, socioeconomic or occupational factors. A small part of the increase might be due to a rising total necropsy-permit rate, and a small accentuation of the increase in 1 5-yr. period may be explained by a temporarily higher necropsy-permit rate in clinically diagnosed cases of lung cancer. It is probable that most of the increase in lung cancer was selective, real, absolute and disproportionately greater than the increase in cancer in general. It is also probable that the increase represents existing conditions in this regard in this socioeconomic group, if not of the entire county population. Assuming that the known tumor-induction time for recognized pulmonary carcinogens in man and experimental animals applies in this case, the current smog situation, which is of recent advent, could not be responsible for the higher incidence. However, this assumption may be false, and smog should not be exonerated. Further investigation is needed.

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Steiner, P.E., et al. (continued)
Other than this possibility, the causes are not apparent. Regardless of whether or not the increase was real, absolute and disproportionate to all cancer, or whether it is still continuing, the present level is so high as to make lung cancer a public health problem of major concern and worthy of further investigation in the area.

78. Allcut, E.A., Chairman, Joint Committee: Atmospheric pollution in Canada. Eng. J. 34:448-52, 1951.
A joint committee was formed in April, 1949 to prepare a model by-law or ordinance against air pollution that could be adopted and used, with suitable modifications, in any part of Canada. Professor E.A. Allcut was elected chairman. The recommendations of the committee that are embodied in the ordinance are very generally discussed, and the model ordinance is presented. In general, only industrial sources are considered.

79. Anonymous: Air pollution control inside and outside industry. Ind. Health Monthly 11:149, 1951.
A synthetic rubber city grew up during World War II just outside Louisville. This large combination of plants produced such materials as Ca carbide, acetylene, butadiene, vinyl plastics, chloroprene and Buna S and N rubber. From this group of plants and other industries within the area there has arisen a serious problem in air pollution, one which has periodically annoyed some 90,000 residents of the entire west end of Louisville. At various times, schools, churches and even factories have been forced to dismiss persons for a session or a day on account of a severe eye irritation.
Attempts to control this great air pollution problem have started with dust reduction inside and outside the carbide-and acetylene-manufacturing plant. A method was developed whereby the hot gases from the carbide furnaces could be captured and suitably cleaned. Engineering tests show the efficiency of the system to be between 90 and 95%. The effluent solids from the 250-ft. stack were found to be approximately 99% by weight.

80. Cadle, R.D. and Magill, P.L.: Study of eye irritation caused by Los Angeles smog. Arch. Ind. Hyg. and Occupational Med. 4:74-84, 1951.
The data reported in this paper are summarized in the abstract for the Stanford Research Institute: The Smog Problem in Los Angeles County; A Report on the Nature and Causes of Smog. Los Angeles, California, Western Oil & Gas Assoc., 1954, 134 pp.

81. Demole, V., v. Fellenberg, T., Held, A.J. and Schmid, H.: Fluor, carie dentaire et thyroïde: Observations récentes faites en Valais. (Fluorine, dental caries and thyroid; recent observations in Valais.) Bull. acad. suisse sci. méd. 7:440-62, 1951.
The first region considered in this study is that of Sierre-Chippis, in the Rhône Valley. Chippis is populated chiefly by workers of the Al factory, whose environmental problems had been investigated by Cristiani during the period 1920-26. Since the installation of control measures, the damages earlier reported have practically disappeared. Livestock in the neighborhood is "in relatively satisfactory health. Damage suits are being made more and more infrequently. The human population is in good health." Although the soil has gradually accumulated a large quantity of F, this has had no effect on agriculture, animals or human beings. The F content of soil of neighboring villages 7-12 km. from the factory

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ranges from 37-160 mg.% (with somewhat greater concentrations at 10-15 cm. depth) (analyses by Duerst and v. Fellenberg, 1948 and 1949), compared with soil samples of other regions, 9.8-22.4 mg.%. Grass samples from the same regions were 0.63-7 mg.% compared with 0.07-1.27 mg.%. At Chippis itself, the following analyses were made: tap H_2O 0.44 mg. F/l.; industrial H_2O 0.92 mg./l.; cultivated soil near factory 35.4 mg.%; green plants 22.2 mg.%; quackgrass 34.3 mg.%; turnips: root 8.3 mg.%; dried greens 48.9 mg.%; bones from corpse buried in local cemetery for 40 years 1.6 mg.%; long bone of sheep (ash) 553 mg.%, tooth from cow 352 mg.%; maxillary of cow 710 mg.%, compared with fresh cow bone, from village 7 miles away, 380 mg.%. Six workers from Al plant, 31-56 years old and having worked there as furnace men for from 5-35 years showed urinary F excretion from 6.6-13.92 mg./l. compared with young subjects from Geneva excreting 0.2 mg./l. Nothing unusual was seen in these workers, even in the older ones, either as to illnesses or skeletal abnormalities. One had a small nodular goiter. School children (41) were also examined. The average F content of 12 temporary teeth was 10.1 mg.% in enamel, 31.8 mg.% in dentine, compared with F content of 2 teeth from village 36 km. away containing 3 and 7.3 mg.%, respectively. A tooth from an adult who had worked for 29 years in the furnace room contained in enamel 63.9 mg.%, in dentine 133, in root 205, in apex 305. Of 40 children, 2 showed mottling. In Sierre (at 1.5 km. distance from Chippis) H_2O contained 0.12 mg./l. Caries frequency was higher among school children. Of 19 children 8-14 years old, 2 showed signs of hypomineralization. Examination of thyroid showed no abnormalities. In Le Châble (F content of H_2O 0.055 mg./l.) bones examined (human, calf, cow) contained from 1.16-57 mg.%; temporary teeth: enamel 2, dentin 5.2 mg.% Caries incidence was very high. In Sembrancher (F in H_2O 1.4 mg./l.), 77 children 7-15 years old showed a remarkable resistance against caries. F content in enamel of temporary teeth from 16 children was 11 mg.% and in dentine 23.9 mg.%. In 21 children whitish spots were seen on enamel. No differences in the size of thyroid were seen in any of these regions. On the basis of these investigations, the existence of a biological antagonism between I and F is denied.

82. Dyktor, H.G. and Goldston, L.N.: The effects of the steel industry on atmospheric pollution in the Cleveland area. Ind. Hyg. Newsletter 11:22-3, 1951.

The plan of survey and sampling procedures of a study of the air pollution load in the Cleveland area with the steel industry in operation and while the steel industry was closed by a strike are discussed. 546 air samples of 1 hour's duration were taken and analyzed and 120 filter disks were used for the determination of shade numbers, i.e., the soiling effect of air-borne dust. SO_2 during the steel strike ranged from 0-0.389 ppm, but only 1 sample was in the range of 0.290-0.389 ppm air in the southern area of the valley. After the steel strike, the range was from 0-0.489 ppm, but again only 1 sample was in the range of 0.390-0.489 ppm in the northern area of the valley. The mean SO_2 concentration for the strike period was 0.034 ppm and for the poststrike period 0.050 ppm. This increase is not significant. F^-'s during the steel strike ranged from 0-50.0 $\mu g./m.^3$ or over, and there were 6 samples of >50.0 $\mu g./m.^3$ air in the southern area of the valley. After the steel strike, the range was from 0-50.0 $\mu g.$ or over, and there were 4 samples of > 50.0 $\mu g./m.^3$, again in the southern part of the valley. The mean F^- concentration for the strike period was 11.59 and for the poststrike period 11.12 $\mu g./m.^3$. While the foregoing 2 contaminants do not seem to have been much affected by the absence or the presence of the steel-making activities, yet the latter had an appreciable effect on the soiling value of the air-borne dust. Based on a necessarily arbitrary unit, the over-all soiling range during the poststrike period was roughly 50% greater than during the strike. There is no doubt that the emissions of iron oxide and carbonaceous matter

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made their substantial contribution to the soiling effect of air-borne dust, especially in the northern half of the valley. (Mainly author's conclusion.)

83. Ely, S.G.: Air pollution in Pittsburgh. Arch. Ind. Hyg. and Occupational Med. 3:44-7, 1951.

Samples of dust were collected each mo. in 8 cans (6" x 8" x 3') placed throughout the city on the roofs of buildings in 8 districts; the samples were then analyzed. The yearly average %'s for 17 mineral oxides are given for each station, and for all 8 cans for 1948 and for 1949. The values for the latter are: SiO_2-12.3 (1948) and 12.9 (1949); PbO-0.005 and 0.05; Fe_2O_3-13.97 and 13.2; Al_2O_3-2.9 and 3.2; TiO_2-0.7 and 0.4; Cr_2O_3-0.3 and 0.9; V_2O_5-0.09 and 0.5; NiO-0.007 and trace; Mn_2O_3-1.0 and 1.5; CaO-4.8 and 1.7; MgO-1.6 and 0.6; ZnO-7.5 and 13.6; SO_3-18.9 and 18.5; P_2O_5-trace and 0.03; CuO, MoO_3 and As_2O_3-traces for both years. The particle sizes ran practically uniform for the whole city: 75% - 149μ, 15% - 44μ and 10% - <44μ. The monthly analysis from each area is quite constant. A few items show the effect of location, e.g., high Fe_2O_3 near 2 steel mills. The monthly average dustfall for 1938, 1948 and 1949 are plotted. The yearly averages are also represented: 1938 - 60 tons/sq.mi., 1948 - ca.56 tons/sq.mi. and 1949 - ca.52 tons/sq.mi. The fixed C in the dust was plotted similarly. It indicates much better combustion in summer than in winter in 1938; by 1948 combustion was much improved and in 1949 it was not greatly different in winter and summer. The yearly averages are approximately: 1938 - 21%, 1948 - 15% and 1949 - 13%.

84. Ely, S.B., Supt.: Report on Stationary Stacks, Year 1951. Pittsburgh Department of Public Health, Bureau of Smoke Prevention, 1951, 15 pp.

Pittsburgh's monthly average number of hours of smoke for 1945-51 are given; they show a decrease of 67% of hours of total smoke and 77.3% of heavy smoke. Measurements of dustfall, collected in 3 cans throughout the city, show 45.7 tons/sq.mi./mo. for 1951 and 50.3 for 1950. 4 additional cans were used in 1951; with these included in the total the average was 52.9 tons/sq.mi./mo. in 1951. Particulate matter collected by electrical precipitator is tabulated by mo. and station; the city average for 1951 and 6 mo. of 1950 was 0.49 $mg./m.^3$. The composite average for the city of combustible matter collected by the precipitator was 80% indicating that it caught mostly smoke, while the cans, with only 32% combustible matter, caught much extraneous dust. The results of analyses of the dust for 16 metal and non-metal oxides, soluble and insoluble, are given and show the %'s in the air of such possibly toxic constituents as Pb, Cr, V, Mn, As, etc., are so small that they are below the danger point. An estimate of the saving from smoke elimination is calculated at $41/capita. Anti-smoke equipment or smokeless fuel is prescribed by the Pittsburgh Smoke Ordinance. A report of inspectors' work for the last 4 years is included.

85. Goldwater, L.J.: La béryliose chronique. (Chronic berylliosis.) Arch. mal. prof. 12:35-7, 1951.

This is a paper presented during the Nov. 20, 1950, meeting of the Societe de Medecine et d'Hygiène du Travail (Society of Medicine and Industrial Hygiene). It outlines the characteristic aspects of chronic berylliosis on the basis of studies carried out in the U.S.

This industrial disease, the principal manifestation of which is pulmonary granulomatosis, is encountered, wherever there is an exposure to

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Goldwater, L.J. (continued)
the inhalation of vapors or dusts of Be and its compounds, i.e., in the production of Be metal, of fluorescent lamps, fluorescent powder, in ceramics and in the manufacture of Be-Cu alloys. The hazard is not confined to the workers in the Be plants. Inhabitants of houses in the vicinity and persons living in the workers' houses have developed berylliosis. The principal toxic compounds are, in addition to the metal itself, BeO, $ZnBeSiO_2$ (sic) and $ZnMnBeSiO_2$ (sic). Although the threshold concentration for toxicity (MAC) has not yet been established, there is evidence that 0.1 μg./m.^{3} air may have toxic effects. A decrease in incidence has been observed after the introduction of strict precautionary measures. The clinical picture is described as follows: characteristic delayed onset of up to 4-6 years after termination of exposure, independent from duration of inhalation, weight loss, asthenia, dyspnea, tachycardia, painful cough and rales. Occasionally, there were osteo-arthropathy, changes in the blood picture and cyanosis. Be is almost always present in the urine and liver. The typical X-ray picture shows fine nodulation of the entire lungs. 3 case reports demonstrate the described symptoms. a) A 27-year old worker, who had been exposed for 5 weeks to Be metal and Be salts, developed pulmonary granulomatosis 6 years after leaving the exposure. He showed a weight loss of 15 kg. b) A 23-year old woman had been living for 5 years at a distance of 100 m. from a Be-manufacturing plant. On returning to the same house after an absence of 2 years (living farther away), she, too, developed pulmonary granulomatosis. Her weight loss is given as 20 kg. c) A 7-year old girl, who had lived since her birth at 700 m. distance from the same plant, developed pulmonary granulomatosis resulting in death. Spectrographic tissue analyses showed the following Be contents: in the lymph glands - 0.665 μg./100 g., in the lungs - 0.237 μg./100 g. In the discussion, it is stated that, even though the incidence of the disease in France has been, so far, rather infrequent, the problem is one of great importance.

86. Heimann, H., Reindollar, W.F., Brinton, H.P. and Sitgreaves, R.: Health and air pollution. A study on a limited budget. Arch. Ind. Hyg. and Occupational Med. 3:399-407, 1951.

A method of studying air pollution in relation to human morbidity is described. 776 households (2,670 persons) were surveyed; 46% lived in a low dustfall area and 54% in a high dustfall area. The socioeconomic status of the residents of the 2 areas were comparable. Only the symptoms of cough and headache reveal a substantial sex difference, the former being more frequent among males and the latter more frequent among females. In general, the recorded frequencies of the various chronic diseases show the expected increases with age and are not strikingly different in the low and high dustfall areas. Among the acute illnesses that reportedly had occurred during the previous 30 days, the common cold was reported more frequently than any other condition, i.e., for 23% of all persons in the survey. In the low dustfall area it was reported for 19.9% of the people, while in the high dustfall area it was reported for 25.6% of the people. The difference of 5.7% is statistically significant. Occupation had little significance.

87. Los Angeles County Air Pollution Control District: Second Technical and Administrative Report on Air Pollution Control in Los Angeles County, 1950-51, Los Angeles, 1951, 51 pp.

The distinctive meteorology of Los Angeles County and how smog affects the people, viz., in reduction of visibility, eye irritation, crop damage and local nuisances, are reviewed. The contaminants of the air consist of smoke, dusts and fumes of many kinds, SO_2 and unsaturated hydrocarbons. The ways in which smog is controlled, viz., by investigating

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Los Angeles County Air Pollution Control District. (continued)
smog sources with diligent law enforcement, improving operational technics, requiring permits for installing new equipment and studying air pollutants, are discussed. The administration of the control district is discussed in detail. Methods for the analysis of lower aldehydes, hydrocarbons, organic acids, O_3, total oxidants, N oxides, hydroperoxides, SO_2, CO and aerosols, viz., solids, acid and oil droplets and ether-soluble material, are given. The calculation of the relative pollution index (R.P.I.) is shown. The chemical properties of smog are outlined. The gaseous components and the ether-soluble aerosols of natural and various synthetic smogs were compared spectrographically to determine smog constituents. The eye-irritating qualities of the constituents were also tested. The total daily emissions to the Los Angeles atmosphere are reviewed. The calculation of dispersion volume is discussed. The concentrations of materials now present in the atmosphere are compared with levels of pollution in past years under similar meteorological conditions; this shows a greater reduction in pollution than is at first apparent. The research on the effects of the natural and synthetic smogs on vegetation are reviewed. For a more detailed account of the results, see the abstract for Stanford Research Institute: The Smog Problem in Los Angeles County; A Report on the Nature and Causes of Smog. Los Angeles, Calif., Western Oil & Gas Assoc., 1954, 134 pp.

88. Sterner, J.H. and Eisenbud, M.: Epidemiology of beryllium intoxication. Arch. Ind. Hyg. and Occupational Med. 4:123-51, 1951.

During the past few years, the incidence of >100 cases of chronic pulmonary granulomatosis and of >200 cases of acute pneumonitis due to the exposure to Be have been reported. The environmental aspects of the 2 types of Be disease, both of occupational and nonoccupational origin, are discussed. The systems most frequently affected and the changes generally observed are classified as follows: I - integument (skin and external eye tissues): contact dermatitis of eczematoid nature; Be ulcer or subcutaneous granuloma; lesions of the skin, of conjunctiva and cornea; II - respiratory tract: rhinitis, tracheitis, bronchitis; acute pneumonitis; berylliosis or "chronic pulmonary granulomatosis." Animal experiments have demonstrated the acute toxicity of Be per se and the capacity of Be phosphors to cause granulomatous lesions but have failed to produce, so far, the latter in the lungs. The clinical, roentgenologic and pathologic syndrome resulting from the exposure to Be and its compounds is characteristic for the action of these substances. Acute pneumonitis can be caused by a single exposure to $>100\gamma Be/m.^3$ in the air.

The relationship between exposure and incidence of nonoccupational chronic Be disease was demonstrated in persons living in the vicinity of a Be-producing plant. At distances of >3/4 mi. from the plant, no one was affected; at <3/4 mi., where the Be concentrations were found to be $< 1\gamma/m.^3$, a total of 13 cases have been reported; at 1/4 mi., at a concentration of $1\gamma Be/m.^3$ air, the incidence was 1%. However, of 1,700 workers in the plant, exposed to mg. concentrations of Be during their work, only 6 (0.3%) had chronic occupational berylliosis. Although many workers had been exposed for as long as > 10 years, there was no incidence of Be poisoning in those exposed for > 4 mo., nor among those whose exposure was to Be compounds other than BeO. There are great variations as to the conformance of the observed forms of Be intoxication to conventional patterns of occupational disease. The author discusses the dermatologic evidence of Be as primary irritant and sensitizer. In severe chronic cases, there frequently are considerable disproportions between exposure concentration and severity of the resulting pathologic changes, or between the latter and the Be concentrations found in the tissues of the affected persons. At concentrations of $> 1\gamma Be/m.^3$

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of air, there is no apparent relationship between exposure and effects. The pathogenesis of Be disease as a modified immunologic reaction is discussed.

89. Wynder, E.L. and Graham, E.A.: Etiologic factors in bronchiogenic carcinoma with special reference to industrial exposures. Report of eight hundred fifty-seven proved cases. Arch. Ind. Hyg. and Occupational Med. 4:221-35, 1951.

857 cases of proved bronchiogenic carcinoma were analyzed; these included 803 males (752 in the U.S.A. and 51 in Europe) and 54 females (in U.S.A.). An examination of the distribution of 760 male patients with epidermoid, undifferentiated or unclassified bronchiogenic carcinoma according to tobacco consumed over a 20-year period showed the highest percentages of cases were heavy and excessive smokers, 34.9 and 30.5%, respectively, 20.8% of the cases were chain smokers, and only 9.7, 2.6 and 1.4% were moderately heavy, light and non-smokers, respectively. Statistical evaluation of the locality distribution data revealed "no systematic statistically significant difference" in locality distribution between the lung cancer patients and the other chest disease patients. The data for this comparative evaluation was taken only from the Barnes Hospital Chest Service, St. Louis. The remaining incomplete "locality data show a suggestive higher frequency of lung cancer among city patients." The distribution of the patients relative to occupation is examined in detail and the role of occupation in lung cancer is discussed at some length.

90. Adams, D.F., Mayhew, D.J., Gnagy, R.M., Richey, E.P., Koppe, R.K. and Allen, I.W.: Atmospheric pollution in the ponderosa pine blight area, Spokane County, Washington. Ind. Eng. Chem. 44:1356-65, 1952.

The ponderosa pine trees in the industrialized area north of Spokane, Wash. have exhibited a characteristic reddening of the needles since 1943, known locally as "ponderosa pine blight." The blighted area now embraces approximately 50 sq. mi. and the trees within a 3 sq. mi. area near the center are dead. As a portion of a comprehensive investigation, the concentrations of gaseous F and S compounds in the air during the growing season of 1950 have been determined through operation of 12 air-sampling stations and a mobile air-analysis laboratory. Throughout 2 mo. of observation, concentrations of oxidizable gaseous S compounds in the atmosphere sampled did not exceed 0.10 ppm. Analyses of F, representing gaseous, H_2O-soluble F-containing compounds, are tabulated according to average concentrations in relation to wind direction and air-sampling stations, also according to distance from damage center, and the influence of meteorological and topographic conditions in the area is discussed. The concentration of F was usually less than 5 ppb, but 3 samples showed more than 50 ppb. Analysis of rain H_2O samples obtained during each rainy period throughout Oct. and Nov. 1950 at 82 locations showed that the highest F concentrations fell in the center of damage, whereas many of the highest S concentrations bore no relationship to the location of the 3 major industries near the center of damage. In conclusion it is stated that the atmospheric concentrations of F present did not of themselves establish the minimum concentration of gaseous F compounds in the air required to produce typical F damage. The concentrations of gaseous S compounds were found to be too low to be an independent factor in the pine tree damage. However, the possible synergistic effects of subdamage concentrations of SO_2 in admixture with gaseous F compounds must be thoroughly investigated before any conclusions concerning the possible causes of the pine tree blight can be drawn.

91. Cadle, R.D. and Johnston, H.S.: Chemical reactions in Los Angeles smog. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952:28-34, 1952.

Except near their source of emission, volatile contaminants of low partial pressures (SO_2, NH_3, N oxides, HCHO, total aldehydes and ketones, oxidants, hydrocarbons, acrolein, HCO_2H, organic peroxides, organic halides and H_2S) occur in small amounts (approximately trace - 0.8 ppm on smoggy days, maxima up to 2 ppm), while natural constituents of relatively high partial pressures (N_2, O_2, H_2O vapor and A) occur in large amounts (1% or more). This great difference in concentration calls for a careful interpretation of the kinetic and photochemical data in the literature. The reactions are classified as a) reactions of oxides of N; b) reaction of O_3 with olefins; c) photochemical reactions of aldehydes and ketones and of olefins; d) reactions of organic free radicals in the atmosphere and e) reactions involving aerosols. Under these divisions certain well-known reactions which must certainly occur, experiments to determine the nature of other reactions expected to occur under conditions which exist in the Los Angeles atmosphere and speculations about some reactions which may occur are discussed kinetically and photochemically. It is pointed out that virtually every photochemical reaction expected to occur in the Los Angeles atmosphere may result in the production of an organic free radical, e.g., HO, H_2O, HCO, R and RO_2 which are remarkably stable even though they are highly reactive. These free radicals are capable of removing a H atom from almost any organic substance upon contact, and thus they are expected to be irritating and harmful to living tissues. Though little can be said about reactions involving aerosols, they may be possible chemical or photochemical reactants or catalysts.

92. Cholak, J.: The nature of atmospheric pollution in a number of industrial communities. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952:6-15, 1952.

Monthly samples of atmospheric pollution collected in Cincinnati in 1941 and from 1946-51 were compared with similar data from the following cities obtained either from the literature or from shorter studies of pollution in these cities with the number of samples collected, the range of concentration and the average or mean concentration of each of these being tabulated for the various areas (congested, industrial, residential): Baltimore, Charleston, W. Va., Chicago, Cleveland, Donora, Los Angeles and Salt Lake City. The ranges of average concentrations for each constituent in all of the cities were: CO_2, 0.033-0.39%; CO, 4.0-10 ppm; N oxides, <0.10-0.26 ppm; aldehydes, 0.04-0.18 ppm (formaldehyde); SO_2, 0.023-0.67 ppm; Cl^-'s, 0.016-0.078 ppm; NH_3, 0.014-0.04 ppm; F^-'s, 0.003-0.018 ppm (HF) and suspended PM, 0.18-0.87 mg./m.^{3}. The concentrations of the various components in the PM and the yearly variations in the average concentration of Pb in the atmosphere of various sections of Cincinnati are also tabulated.

93. Cholak, J., Schafer, L.J. and Hoffer, R.F.: Results of a five-year investigation of air pollution in Cincinnati. Arch. Ind. Hyg. and Occupational Med. 6:314-25, 1952.

Samples were obtained from 12-18 fixed stations (selected with respect to prevailing wind direction, population, density of traffic and altitude) for 3 or 4 days of each month from Nov. 1946-Oct. 1951, inclusive. Sampling days were selected on convenience of the field crew, without regard to factors which might influence the concentration of pollutants. Average quantities of settled dust (in tons/mi.^{2}/mo.), collected at 4 representative stations for the 5 yr. were: I (suburban) 13.6, 14.6, 7.7, 9.2, 5.2, average 8.6, range 1.4-43; II (residential near downtown) 26.1, 38.0, 31.0, 28.5, 15.4, average 27.8, range 9.6-116; basin of city, III (industrial

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and commercial) 114.0, 96.0, 72.0, 83.1, 90.0, average 90.5, range 18.5-214; IV (industrial) 148.0, 156.0, 124.0, 89.3, 92.7, average 122.0, range 60.3-257. The progressive decrease in dustfall is attributed to the use of better fuels, increased use of natural gas, improvement in methods of combustion and combustion equipment as well as increased use of diesel-powered switching engines and locomotives. The average concentration and range (expressed as %) of a number of pollutants in the insoluble portion of approximately 300 settled dust samples was as follows: combustibles 56.9, 10.9-79.0; Mn 0.039, <0.01-0.78; Pb 0.122, <0.01-1.7; Sn 0.02, <0.01-0.56; Fe 2.41, 0.06-26.8; Al 1.60, 0.04-7.15; Cu 0.20, 0.01-2.00; Ag <0.005, <0.001-0.31; V <0.005, trace; Ti 0.145, 0.005-2.30; Zn 0.038, 0.001-0.485; SiO_2 (free) 4.3, 0.45-10.6. The range of concentration and mean concentration, respectively, of suspended matter (mg./m.^{3}) in the atmosphere of various sections of the city were as follows: rural (control) 0.02-0.45, 0.18; residential and neighborhood commercial 0.01+-1.3, 0.28; commercial and industrial 0.01-1.98, 0.42; all sections 0.01+-1.98, 0.37. Like dustfall, quantities of suspended matter in the atmosphere were greater during the cold months, although the density of the street traffic and nature of industrial activities contributed toward increasing the suspended particulate matter in the air. The mean concentrations (μg./m.^{3}) of 22 ions found in the suspended matter were as follows:

	Rural	Resi-dentl.	Indus-trial	All areas	Range		Rural	Resi-dentl.	Indus-trial	All areas	Range
Al	1.9	3.5	5.0	4.4	0.1-25	Cu	0.88	0.76	0.90	0.86	0.01-32
Sb	-	-	<0.2	<0.2	-	Fe	5.7	9.4	14.6	12.5	0.1-110
As	-	-	0.06	0.06	0.06	Pb	1.2	2.0	3.2	2.7	<0.1-11.5
Be	0.003	0.013	0.006	0.0095	0.0001-0.06	Mg	<10.0	-	-	<7.0	<5-<10
Cd	-	-	0.22	0.22	<0.10-0.42	Mn	0.20	0.27	0.37	0.30	0.0+-2.0
Ca	9.0	14.0	17.0	16.0	0.4-65	Hg	-	0.11	0.07	0.10	0.03-0.21
K	20.0	51.0	48.0	49.0	<3-230	V	<0.2	<0.2	<0.2	<0.2	<0.2-0.4
Ag	<0.1	<0.1	<0.1	<0.1	<0.1-0.8	Zn	1.6	1.5	2.2	2.0	0.1-14
Na	<20.0	<25.0	30.0	28.0	<10-84	F^-	0.67	0.77	1.03	0.93	0.10-2.90
Sn	<0.2	<0.2	<0.2	<0.2	<0.1-12	$SO_4^=$*	-	1.05	3.8	2.7	0.10-8.5
Ti	<1.0	<1.0	<1.0	<1.0	<1.0-20	Cl^-*	-	0.37	2.9	1.9	0.24-6.6

*Water-soluble (Up to 724 samples were analyzed per constituent.)

Because of several factors, it was felt that the mean concentration of Be in the residential area was distorted. The majority of samples subsequently analyzed contained <0.005 Be/m.^{3} of air. Yearly average concentrations of Pb (μg./m.^{3}) in rural, residential and industrial sections, and the city as a whole, respectively, were as follows: 1946-47 - 0.8, 2.3, 4.1, 3.0; 1947-48 - 0.95, 1.6, 3.4, 2.7; 1948-49 - 1.3, 1.7, 3.6, 2.7; 1949-50 - 1.3, 1.7, 3.5, 2.5; 1950-51 - 1.2, 2.5, 3.0, 2.6; 5-yr. averages - 1.1, 1.94, 3.5, 2.7. These values show a significant decrease from a concentration of 5.1 μg./m.^{3} found during a short-term study conducted in 1941. Another slight decrease occurred after June, 1947, when a city ordinance requiring the use of low-volatile coal in hand-fired units was put into effect. Highest concentrations were found near a large brass foundry and Pb-recovery plant. Increased use of gas and oil for industrial purposes as well as the increasing number of installations of equipment for controlling fly ash, undoubtedly are of greater importance than the new ordinance in explaining the decrease. According to these observations, the Pb level in all parts of Cincinnati ranges from 1/1,500 to 1/15 of the most commonly accepted standard for a safe industrial atmosphere. While it is not suggested that this standard is applicable to a community atmosphere, the margin of safety seems large and ample. Average concentrations of SO_2 in rural, residential and industrial commercial areas, respectively, were: 1947-48 - 0.079, 0.104, 0.112; 1948-49 - 0.026, 0.040, 0.061; 1949-50 - 0.008, 0.023, 0.048; 1950-51 -

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0.015, 0.025, 0.056. The concentrations varied seasonally and with the extent of commercial and industrial activity in the several areas of the city. Quantities of F's as HF (0.00-0.025 ppm) were extremely small and uniform throughout the city. Concentrations of Cl's were also uniform in distribution and ranged from 0.0-0.19 ppm. The mean concentrations of CO were: rural <5.0 ppm; residential 4 ppm; industrial-commercial 9.5 ppm. In a 2-day period when Christmas shopping was at its height, the mean CO concentration at 2 locations in the business area was 20.2 ppm. Range and average concentrations of CO_2 (%) were: rural 0.031-0.039, 0.033; residential 0.030-0.052, 0.037; commercial-industrial 0.032-0.060, 0.039; city proper 0.030-0.052, 0.038. Concentrations of nitrates ranged from 0.00-0.55 ppm, averaging 0.23; NH_3 0.00-0.089 ppm, averaging 0.023; aldehydes 0.00-0.27 ppm, averaging 0.07. The quantities of aldehydes seem to bear a direct relationship to the density of motor traffic. Ozone was not determined. Among the odors which can be detected and identified specifically at times are phenols, fatty acids and H_2S. Analyses of H_2S at times when the odor was recognized rarely showed concentrations in excess of 0.01 ppm in samples collected over a $^1/_2$-hr. period.

94. Clayton, G.D.: Epidemiologic approach. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952:110-6, 1952.
The general outlines for this part of the study are discussed. Engineering data on the industrial emissions in Detroit, information on the socioeconomic status of the population and visual observations of air pollution were gathered for the study. A pilot environmental study was then undertaken on 28 census tracts as determined from the above information, and from this, 6 areas were finally selected for the pilot health study. The preparation for the latter is briefly discussed. The details of the various phases of this study are reported at greater length in:
Katz, M.: The Greater Detroit-Windsor air pollution study. Part II--Investigation of environmental contaminants by continuous observations and area sampling. Am. Ind. Hyg. Assoc. Quart. 13:211-25, 1952.
Clayton, G.D. et al.: Report of Results of Sampling the Atmosphere in the Detroit River Area During 1951. International Joint Commission, Technical Advisory Board on Air Pollution, U.S. Section, 1953, 55 pp.
Peart, A.F.W. and Josie, G.H.: Some considerations in planning a comprehensive study to determine the effects of air pollution on health. (A review of methodology.) Arch. Ind. Hyg. and Occupational Med. 7:326-38, 1953.
Peart, A.F.W., et al.: Pretest of form and field techniques for use in the Detroit-Windsor air-pollution study. Arch. Ind. Health 11:47-52, 1955.
Katz, M.: Atmospheric pollution: A growing problem in public health. Am. J. Public Health 45:298-305, 1955.

95. Clayton, G.D., et al.: The Detroit-Windsor air pollution study. Public Health Repts. (U.S.) 67:658-71, 1952.
The 6 major papers on the Detroit-Windsor air pollution study given at a symposium on Apr. 22, 1952 in Cincinnati, Ohio and jointly sponsored by the American Conference of Governmental Industrial Hygienists and the American Industrial Hygiene Association are briefly presented.
Clayton, G.D.: Objectives of the Detroit-Windsor air pollution study. pp. 658-61.
Brinton, H. P. and Gafafer, W.M.: Statistical analyses in air pollution studies. pp. 661-4.
Katz, M.: Environmental studies--general area sampling. pp. 664-6 (for abstract, see Katz, M., Am. Ind. Hyg. Assoc. Quart. 13:211-25, 1952.)
Radcliffe, J.C.: Industry's part in the study. pp. 666-8 (for abstract, see Radcliffe, J.C., Am. Ind. Hyg. Assoc. Quart. 13:206-10, 1952.
Baynton, H.W.: Environmental studies--meteorological aspects. pp. 668-9.
Molner, J. G. and Fredrick, W. G.: Environmental studies--health aspects. pp. 669-71.

96. Dawson, K.B.: Radioactive material in the atmosphere. Brit. J. Cancer 6:22-31, 1952.

The radioactivity of suspended matter in air, as measured in London (3 sites), Manchester and Rothamsted, rural area, showed no significant difference between urban and rural districts. Mean activities ranged from 34.4 x 10^{-12}c./m.^{3} in Rothamsted to 96.5 x 10^{-12} in central London, with extremes ranging from 2.9 x 10^{-12} (Hospital, London)-21,675 x 10^{-12} c./m.^{3} (air raid shelter, central London). Higher activity occured in Dec.-Jan. and lower one in Apr.-May (roof of St. Bartholomew's Hospital). Rate of wind caused large variations. There was variation with height up to 100 ft. above ground level. In closed places (air raid shelter), the highest activity was $\geqq$100 X that in the street. Even these are small compared with lowest amounts considered harmful to man. On introducing smoke into a small room, there was an immediate increase in activity, showing that in a small room there is never an appreciable quantity of free radioactive atoms; they either become attached to dust or migrate to the walls.

97. Ely, S.B., Supt.: 1952 Report of the Bureau of Smoke Prevention. Pittsburgh, Pa., Department of Public Health, 1952, 17 pp.

A reduction of 7.5% of total smoke in '52 over '51 and of 69.5% in '52 over '46, and a reduction of 58.8% of heavy smoke in '52 over '51 and of 93.0% in '52 over '46 was observed in Pittsburgh. Suspended matter, collected at 12 stations, averaged 0.55-0.90 mg./m.^{3} air/mo. for Sept.-Dec., 1952. Dustfall collected in 12 cans throughout the city averaged 51.6 tons/mi.^{2}/mo. compared with 52.9 in '51. The smoke inspectors' reports and the report on Pittsburgh railroads are also included.

98. Gabovich, R.D.: (Fluorine in water of atmospheric precipitations.) Dopovidi Akad. Nauk Ukr. R.S.R. 1952:397-400. (Russian summary.)

In most parts of 43 regions of Ukraine and U.S.S.R., the F content was n.10^{-6}%. The large quantities of F pass into the atmosphere from the earth's surface (evaporation of sea H_2O, soil, volcanic activity, combustion of coal, superphosphate factories, etc.). Average F content of H_2O from rain and snow on the Ukrainian territory is 0.0524 mg./l., or 15,117 tons/yr. The principal rivers of Ukraine take out 11,671 tons/yr.

99. Goulden, F., Kennaway, E.L. and Urquhart, M.E.: Arsenic in the suspended matter of town air. Brit. J. Cancer 6:1-7, 1952.

Determination of As in suspended matter of town air showed a monthly mean of 0.104 µg. As_2O_3/m.^{3} for Nov.-Jan. at 8 sites. The mean for the rest of the year was 0.055 µg. The maximum, 0.132 µg., occurred at Beckton, London and was ca. 3.5 X the minimum, 0.037 µg. at Bristol. The 2nd highest concentration, ca. 0.077 µg., was at Bilston; Manchester, Liverpool and Sheffield had ca. 0.07 µg. and Hull and County Hall, London, 0.054 and 0.058 µg., respectively. It is estimated that at 0.07 µg. As_2O_3/m.^{3} air the "standard man" would breathe in 0.5 mg./yr. or 35 mg. in 70 yr. A person smoking cigarettes containing 50 µg. As_2O_3/cigarette would volatilize 0.5 mg. in smoking 100 cigarettes. A possible summation of carcinogenic effects on which agents in town air, e.g., benzpyrene and As, might have a supplementary effect is discussed.

100. Haagen-Smit, A.J.: Chemistry and physiology of Los Angeles smog. Ind. Eng. Chem. 44:1342-6, 1952.

Under smog conditions, the time required by O_3 to crack bent rubber strips (method of O_3 determination) was greatly reduced from 45 min.-6 min., which corresponds to 0.03 and 0.22 ppm, respectively. Using the peroxidase test to distinguish reaction products resulting from the action of strong oxidizing agents on organic compounds from NO_2 and O_3, high concentrations of peroxides were obtained during smog. In fumigation experiments with O_3 and various organic substances, maximum damage on spinach, beets, endive, oats and alfalfa was obtained with O_3 and straight chained olefins having the double bond in

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the 5th or 6th position, of cyclohexene and of branched-chain isomers of these olefins. Since fumigations with the end-products of oxidation of these hydrocarbons gave no plant damage, it is concluded that the intermediate peroxide compounds are the active agents responsible for damage.

Studies of eye irritation from oxidation of cracked gasoline in sunlight were done in fumigation chambers built of Plexiglass. 0.4 ppm NO_2 and 0.2 ppm O_3 were reacted with 10°C. fractions of gasoline. When 10 ppm hydrocarbon were used, irritation was pronounced with those in the 35°-90° C. boiling range. With hydrocarbon concentrations of 1.6 ppm, eye irritation was definite in the range of 50°-80°C. (this is comparable to results for plant damage), and in fractions boiling below 35°. Experiments using only NO_2 as the oxidant gave similar results. A similar series of experiments were run using pure olefins, viz., ethylene, propene, 1-butene, 2-butene, isobutene and 1-hexene in various concentrations. The oxidant concentration was constant, 0.4 ppm NO_2 and 0.2 ppm O_3 with sunlight. Definite effects were obtained with 0.2 ppm 1-butene and 0.5 ppm 2-butene. Severe smog effects occurred with 0.5 ppm 1-butene. Formaldehyde, since it occurs in concentrations below its irritation threshold, can only be considered as a secondary smog irritant.

It was noted in these fumigation experiments that in oxidation of ring compounds having a double bond in the ring, the opening of the ring yields practically nonvolatile oxidation products, and thus aerosol formation, which produces reduction in visibility.

Chromatographic and spectrographic analyses of smog have shown the presence of many aldehydes and organic acids, and of a multitude of hydrocarbons; mass spectrograms from mixtures of hydrocarbons oxidized with O_3, N oxides and UV light compare with those recorded from smog. The excess oxidant present on severe smog days amounts to 0.5-0.6 ppm (calculated as O_3). To account for this excess formation, a chain mechanism is postulated in which, probably, free radicals and peroxides play a role in the transfer of an oxygen atom to an oxygen molecule.

101. Haagen-Smit, A.J., Bradley, C.E. and Fox, M.M.: Formation of ozone in the Los Angeles smog. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952:54-6, 1952.

The information in this article is contained in the following abstracts.

Haagen-Smit, A.J.: Chemistry and physiology of Los Angeles smog. Ind. Eng. Chem. 44:1342-6, 1952.

Haagen-Smit, A.J., Bradley, C.E. and Fox, M.M.: Ozone formation in photochemical oxidation of organic substances. Ind. Eng. Chem. 45: 2086-9, 1953.

Haagen-Smit, A.J. and Fox, M.M.: Photochemical ozone formation with hydrocarbons and automobile exhaust. Air Repair 4:105-8, 136, 1954.

102. Haagen-Smit, A.J., Darley, E.F., Zaitlin, M., Hull, H. and Noble, W.: Investigation on injury to plants from air pollution in the Los Angeles area. Plant Physiology 27:18-34, 1952.

Spinach, beet, endive, oat and alfalfa plants were used for the determination of crop damaging pollutants of the Los Angeles area. The production of a metallic glaze or silvering on the lower surface of leaves on spinach, beet and endive especially distinguishes this damage from the effect of previously known toxic materials. The results of fumigation experiments with individual gaseous air pollutants, gasoline, gasoline and O_3, unsaturated hydrocarbons and O_3, and unsaturated hydrocarbons plus oxides of N_2, SO_2, UV light or sunlight on each of the test plants are tabulated. The reaction products of O_3 with unsaturated hydrocarbons produced typical smog damage on all of the indicator plants. The damaging

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factor is attributed to the peroxides formed in the ozonization process. Optimum effects were obtained by using olefins with 5 and 6 C atoms with the double bond in the end position. However, the end position of the double bond is not essential, since 3-n-heptene, 4-n-nonene and cyclohexene gave typical smog damage upon ozonization. The concentration of O_3 at which damage occurs with the olefins is well within the range of O_3 concentration found in the atmosphere as determined by the rubber cracking test. The optimum activity of the C_5 and C_6 series is attributed to the stability of the intermediate products in the reaction process. The catalytic oxidation of the olefins with NO_2 under the influence of sunlight produces oxidation products very similar to those produced by O_3. In the plant fumigation with oxidation products of olefins, lachrymatory effects were often observed.

103. Hemeon, W.C.L.: The Nature of the Air Pollution Problem in the City of New Haven, Report of a Survey. Pittsburgh, Industrial Hygiene Foundation of America, Inc., 1952, 67 pp.

The Industrial Hygiene Foundation was requested by the Air Pollution Study Committee of New Haven to undertake a technical survey which would constitute an objective evaluation of the air pollution problem in New Haven. In the report of this investigation, the general characteristics of New Haven (population in 1950 about 165,000) are reviewed, with particular emphasis on the domestic and industrial fuel consumption, and the nature and origins of smoke and dust are discussed. According to complaints, the problem in New Haven was mainly one of dust fall, and therefore an inventory of the stack dust emissions was made. The fuel dust stack emissions by type of equipment are estimated to total 20-25 tons dust/day, with the largest amount, 17 tons/day, coming from 4 plants using large scale stoker firing equipment for coal and coke.

The city dust fall was measured by exposing open-top glass jars located on roof tops at 15 different locations and recording monthly weight data. The results are compared by types of districts and according to the seasons of the year. In the city residential (adjacent to industrial) districts there were 27, 23 and 13 tons/sq.mi./mo. in winter, spring and summer, respectively; in the commercial districts the respective figures were 21, 18 and 12; in the city residential (removed from industrial) districts, 18, 17 and 11; and in the suburban 18, 12 and 7. The same comparisons with other cities, Holyoke and Amherst (1949), Milwaukee (1952), Wyandotte (1952), Seattle (1951), led to the following general conclusions: (a) in the summer months all areas of the city are as clean (as measured by dust fall weight) as the typical suburban area of any American city and (b) in the winter months there are few cities of comparable industrial activity whose dust fall is as low as that of New Haven. In order to obtain a more complete picture of relative dustiness between different sections of the City, small glass plates coated with a film of adhesive were exposed on 12 selected days (ranging from Mar.-Aug.) for short periods of a few hrs. at 55 locations throughout the city. The averaged results, summarized by zones on a map of the city, show highest dustiness in the central industrial district and also high dustiness along parts of the eastern shore.

The relative importance of dust fall origins, i.e., industrial emissions, domestic fuel burning and wind blown dust, are discussed. Chemical analyses of the composition of city dust for C, SiO_2, V and S were made and the results of both coarse and fine dusts tabulated according to 4 districts. Since the principal source of the V and S was fuel oil (No. 6), these elements gave a good indication of the extent to which the burning of heavy fuel oil contributes to the total dust.

The general conclusions on nature and origin of city air pollution may be

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summarized as follows. The contribution to dust fall in the City due to tall industrial chimneys is not over 20-25% in cold weather, and at most 30-35% in the summer months. Regulation of the emission of fuel dust in accordance with standards of good industrial practice would reduce dust emissions to 10-15%. There are probably local areas in the vicinity of short stacks that are exposed to materially higher than average dust fall. (An actual survey of this was not practical.) Stack emissions from burning of No.6 fuel oil represent a small contribution, by weight, of total City dust, but a high proportion of the C. Measures which effected a reduction in blackness of the dust fall, i.e., large scale improvement in the combustion of No.6 fuel oil, even though accompanied by inappreciable reduction in total dust fall weight, would be noted as an improvement by citizens.

A draft of a proposed ordinance for air pollution abatement in New Haven is given in Appendix I, and a discussion of the ordinance provisions is presented.

104. Humphrey, P.A.: Brief discussion of the meteorological program at the National Reactor Testing Station, Idaho, with emphasis on the atmospheric dust program currently in progress. In: Sanitary Engineering Conference held at South District Filtration Plant, City of Chicago, U.S. Atomic Energy Commission, 1952, pp. 143-54.

The meteorological program of the National Reactor Testing Station (NRTS) is described. The 3 instruments used in the atmospheric dust program, viz., the high volume air sampler, the apparatus used to collect particles for size analyses and a simple wind instrument, are described and photographed. Already sufficient samples have been obtained to show that under natural conditions the air over most of the NRTS is as free of dust as any relatively clean rural area. Size analyses indicate the dust has a median size of ca. 0.4 μ.

105. Irving, R.J.: Tests on some impurities in the atmosphere of Leeds. Leeds Philosophical and Literary Society, Scientific Section, Proceedings 6: 14-7, 1952.

Hourly measurements of soot and SO_2 were made on clear sunny days and foggy days in Leeds, both outside and inside the Brotherton Library of Leeds University during the period of Jan.-July, 1951. In outside air in fog there was 25 times as much soot as on a clear day; the actual concentration was not measured. SO_2 concentration on a clear day was as low as 0.05 ppm and on a very foggy day as high as 1.95 ppm. SO_2 maxima occurred between 5 p.m. and 11 p.m. and minima between 2 a.m. and 5 a.m. In a room not air conditioned results were similar, but filtering through gauze removed nearly all soot and SO_2, showing that much of the SO_2 was adsorbed on the soot particles. Tests at Sheffield showed ca. 0.7 ppm NO_2 and ca. 0.2 ppm SO_2.

106. Katz, M.: The Greater Detroit-Windsor air pollution study. Part II--Investigation of environmental contaminants by continuous observations and area sampling. Am. Ind. Hyg. Assoc. Quart. 13:211-25, 1952. (Also appeared as: Sources of pollution.) Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952:95-105, 1952.

The Detroit River area is the 3rd largest manufacturing region in North America with over 5,000 major industrial establishments of many types. About 28,000 vessels are estimated to go up or down the Detroit River in the navigation season and consume ca. 16 million tons coal/yr. Besides this, the total domestic and industrial consumption of coal and solid fuels is ca. 15 million tons/yr. on the U.S. side and ca. 650,000 tons on

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the Canadian side. Assuming S content of the fuel to be 1.5% and that 90% of this S is released to the atmosphere, approximately 430,000 tons SO_2 are emitted from solid fuels alone, not counting other fuels and industrial processes. Also many other process wastes consisting of gases and aerosols contaminate the atmosphere. Data on smoke emission from river vessels were collected and reported by Canadian investigators, and a marked improvement in smoke performance has been noted. A summary of meteorological data, i.e., direction and hourly speed of wind and number of cloudy days, in the Detroit-Windsor area by month for 1945-49 is given. In general, lower winds and less cloudy days occur in the summer months. The prevailing wind is SW, except in Jan. and Feb. when it is W. The monthly mean and maximum concentrations of SO_2 (ppm) at 4 stations in Windsor area from Sept. 1950-Dec. 1951 are tabulated. The months during which the pollution level is highest, viz., Apr., May, Nov. and Dec., coincide with the period of the year showing the greatest number of cloudy days and highest incidence of temperature inversions. At the station near the Windsor-Detroit Tunnel entrance (greatest pollution), the mean concentration varied from 0.047 (June '51) - 0.149 (Dec. '51), with the maximum concentrations ranging 0.207 (Mar. '51) - 0.557 (Dec. '50). At the station 15 mi. S of Detroit River (least pollution), mean concentrations ranged 0.0008 (Apr. '51) - 0.0266 (Dec. '50), while maximum concentrations ranged 0.031 (Mar. '51) - 0.307 (Nov. '50). Higher peak concentrations of very short duration were recorded in Nov. (1.105) and Dec. (1.210) '51 and Jan. '52 (2.706 ppm for 4 min.) Such concentrations are greater than those recorded in Los Angeles and Yonkers, N.Y., etc. However, no major smog disaster has occurred as yet because of the topography of the area. Intermittent samples of H_2S, Cl_2, N oxides and NH_3 were collected and the mean and maximum concentrations of these by location are given. High concentrations of suspended PM usually coincide with periods of smog and relatively heavy SO_2 concentration. Daily average concentrations for the area from Oct. 24-Dec. 5, '51 ranged 0.067-0.260 mg./m.^{3} The mean, minimum and maximum concentrations (mg./m.^{3}) at 26 stations in the Windsor area are tabulated. The most heavily polluted areas on the Canadian side lie close to the Detroit River and in zones of major industrial operations; moderate to low pollution occurred in the E and S of Windsor, and the lowest in Tecumseh and McGregor, Ontario. The distribution of deposited matter, including total solids, insoluble/H_2O and soluble/H_2O solids, tar, other combustible matter, ash, S as $SO_4^=$, Cl, lime and pH, at 20 stations for the period approximately from Aug.-Dec. '51 is tabulated. A mean of 92 tons/sq.mi./mo. of total solids was recorded in the heavily polluted areas; 53.9 in the heavy to moderate polluted areas; and 42.7-35.9 in the moderate-low areas. The average monthly dustfall pollution in the heavily contaminated area of Windsor is apparently greater than that reported for Chicago, Cincinnati, Los Angeles, Toronto and for Pittsburgh in 1950. X-ray diffraction analysis of the suspended PM identified about 20 metals and showed Ca, Si, Al and Fe to be the most abundant, and Pb, Cu, Zn and Mn the next most abundant. All these studies of the environment are being correlated with a view to providing enough information to serve as a basis for surveys of the effects of such conditions on public health, vegetation, safety and economy.

107. Keenan, R.G. and Byers, D.H.: Rapid analytical method for air pollution surveys. Arch. Ind. Hyg. and Occupational Med. 6:226-30, 1952.

A determination of total particulates and a rapid semi-quantitative spectrographic method of analysis of the metallic constituents in high-volume samples are described in detail, i.e., as to method of sampling, weighing procedure, sample recovery and preparation of sample spectrograms. The results obtained for Fe and Pb by this method were compared with those obtained by chemical analysis; the spectrographic method was found to be less

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accurate. The comparisons are tabulated. However, the authors maintain that the method gave results that were adequate for statistical analysis in regard to epidemiologic and engineering planning.

A comparison of the average concentrations determined by this method of 19 metallic elements and Si in the urban atmospheres of Detroit (1,035 samples analyzed), Windsor (82 samples) and Charleston, W.Va. (9 samples) is tabulated. The total % of metallic elements found in these city atmospheres is reported as 6% for Detroit, 11% for Windsor and <5% for Charleston.

108. McCabe, L.C. and Clayton, G.D.: Air pollution by hydrogen sulfide in Poza Rica, Mexico. An evaluation of the incident of Nov. 24, 1950. Arch. Ind. Hyg. and Occupational Med. 6:199-213, 1952.

Since the reactors for converting H_2S from natural gas to S were not yet complete at the new S-recovery plant at Poza Rica, Mexico, the H_2S rich gas absorbed in the Girbotol units (operation started Nov. 21, 1950) was sent to a flare, 90 ft. above the ground, at a rate of 10,000,000-11,000,000 ft.^{3}/day. S-free natural gas was added to assure a combustible mixture. When the scrubbers were first put into operation, difficulty was encountered and some of the absorption solution overflowed, partly plugging the gas lines to the pilot lights, and the flare was reduced in height. The absorption units were shut down, the lines drained and the flare relighted; it then burned normally. On Nov. 24, at approximately 2:00 a.m., efforts were made to increase the rate of flow of gas to the plant's rated capacity of 60,000,000 ft.^{3}/day. The desired rate of flow was reached at approximately 2:30 a.m. At approximately 4:00 a.m. difficulty was encountered, and the gas flow began surging through the unit, with the probable result that unburned H_2S escaped into the atmosphere.

Poza Rica lies on the Rio Cazones flood plain (el. 173 ft.) with hills surrounding the valley. At that time, low altitude temperature inversion, little wind movement and pronounced fog prevailed, and thus prevented the normal mixing and dispersion of the stack effluents. The wind direction was the major contributing factor affecting the flow of contaminants.

The houses consist mainly of 1 room and are built to allow maximum air movement. The people in the affected area (N of the plant) were aroused from their sleep in the early morning by an air pollutant which, from 4:50-5:10 a.m., when maximum concentration of H_2S was reached, resulted in the hospitalization of 320 persons, with death of 22 persons ranging in age from 2-50 years (9 were under 13 years of age, 10 between 14-35, 3 between 36-50). Of the total 320 treated at the hospital, 170 were discharged after 2-3 hrs., 90 after 6-7 hrs., 32 after several days; 17 died within 6 hrs. after arrival at the hospital and 5 after 1-9 days. Of the animal population, all the canaries in the area were reported killed and approximately 50% of all other animals died.

The exposure produced loss of the sense of smell, irritation of the respiratory system with a high frequency of cough, dyspnea and pulmonary edema, of the conjunctiva from direct contact with the contaminants, of the gastrointestinal tract with nausea and vomiting, of the nervous system with unconsciousness, severe headache and vertigo. The effects of the exposure on the respiratory and digestive systems did not last long, indicating rapid oxidation in the body of the toxic substance to the nontoxic product. The effect on the nervous system was more prolonged, and the degree of this effect was the determining factor in the fatalities. Selected pertinent clinical findings and the frequency of symptoms and signs on 47 hospitalized persons are tabulated. 9 case

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McCabe, L.C., et al. (continued)
histories typical of the acute onset and sudden death, as well as the symptoms and signs are presented. 4 of the survivors exhibited nervous system sequelae, acoustic neuritis, dysarthria and aggravation of epilepsy attributable to damage to the nervous tissue from asphyxia and prolonged anoxemia.

A necropsy was performed on a 22-yr. old woman who had died suddenly. Gross and microscopic examination gave the diagnosis of pulmonary edema and congestion, cerebral congestion and patechial hemorrhage. Sections of a dog's lung showed marked congestion and edema; there was passive congestion and fatty degeneration in the liver.

109. Magill, P.L.: Sampling procedures and measuring equipment. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 6, 1952, 40 pp.

General considerations, e.g., purpose of samples, questions to be asked before sampling and general principles of sampling, are discussed. All types of sampling equipment are reviewed. 116 references are cited, and a comparative summary of sampling devices and diagrams and photographs of many of the instruments are included.

110. Magill, P.L. and Benoliel, R.W.: Air pollution in Los Angeles County. Contribution of combustion products. Ind. Eng. Chem. 44:1347-51, 1952.

"Combustion products from approximately 50,000 tons/day of fuel and rubbish are emitted to the atmosphere in Los Angeles County. Public and industrial burning of these materials emits to the area each day at least 1800 tons of impurities, not including CO." Approximately 70% of this amount is organic in nature, 15% - N oxides and 15% - SO_2. Household burning of 4000 tons of trash, the biggest single source, sends 550 tons of organic materials/day into the air. Exhaust fumes from approximately 2,000,000 automobiles, busses and trucks in the county contribute another 350 tons of organic substances, 30 tons of aldehydes and 40 tons of N oxides. Detailed data are presented showing the sources of the various impurities and the quantity each source emits.

111. Magill, P.L., Hutchison, D.H. and Stormes, J.M.: Hydrocarbon constituents of automobile exhaust gases. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952:71-83, 1952.

The exhaust gases of automobile passenger cars, 5 prewar and 5 postwar in random mechanical condition, were analyzed for C_1 to C_7+ hydrocarbon content with the mass spectrometer. The hydrocarbons found include methane, acetylene, paraffins and olefins from C_2 to C_7+. The exhaust composition was found to be independent of the type of gasoline burned, using gasolines ranging from premium gasoline of present-day producers to saturated straight-run gasoline typical of prewar production. New cars and old cars showed relatively little difference in exhaust composition during acceleration and steady driving. Under conditions of idling and deceleration, the hydrocarbon content exhausted from prewar cars was approximately twice that of postwar cars. Over the range of driving conditions encountered in city traffic, there is a loss of hydrocarbon out of the exhaust ranging from 5% of the weight of fuel entering the carburetor under conditions of steady driving to 19% during periods of deceleration. The total quantity of C_1 to C_7+ hydrocarbons released by automobile exhausts to the atmosphere over Los Angeles County during a 24-hour day is estimated to be about 850 tons.

112. Mader, P.P., MacPhee, R.D., Lofberg, R.T. and Larson, G.P.: Composition of organic portion of atmospheric aerosols in the Los Angeles area. Ind. Eng. Chem. 44:1352-5, 1952.

Ether-soluble aerosols in significant amounts were collected from the atmosphere with the help of a mechanical filtering system. They were shown

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Mader, P.P., et al. (continued)
by chemical and spectographic means to contain sizable amounts of oxygenated and peroxidized organic substances. The quantities of aerosol per unit volume of air differed from day to day, depending on the degree of pollution, but the chemical composition remained rather uniform. Similar analysis of synthetic smog produced in the laboratory from hydrocarbon mixtures in conjunction with other atmospheric pollutants and sunlight identified essentially the same kind of aerosols. The particle size range of aerosols in both naturally occurring and synthetically produced smog was determined at 0.3-0.8μ; it is at this size that particles cause maximum visible light-scattering. Although many types of organic materials emitted into the atmosphere in the Los Angeles area are capable of being oxidized, hydrocarbons are by far the largest in quantity. The oxidation of certain hydrocarbons, which are emitted into the atmosphere from a variety of sources, contributes in substantial part to the organic aerosols collected on mechanical filters in and around Los Angeles. When considered along with dust, fumes and other pollutants already identified, the ether-soluble aerosols in the atmosphere provide a convenient criterion for indicating the extent of air pollution and the progress of control activities.

113. Mills, C.A.: Air pollution and community health. Am. J. Med. Sci. 224:403-7, 1952.

Death rate studies, specific for age, sex and color, were made in Chicago's most polluted and cleanest contrasting areas. The death rates for pneumonia rose sharply in all categories with advancing age, were always higher for male than for analagous sections of female populations, and were always higher in the dirty areas than in the clean. In the cleanest areas, rates/100,000 ranged from 6 (ages 30-39) - 324 (ages ≧ 75) for males and 3 - 171 for females; in the dirtiest areas they ranged 38 - 497 for males and 10 - 267 for females. The ratios of the rates for the dirty and the clean areas were greatest for the youngest age-decade studied (30 - 39 years) and lessened steadily on toward the old-age extreme for both sexes (for males, from 6.27 at ages 30-39 down to 1.53 at ages ≧ 75; for females, from 3.33 at 30-39 to 1.56 at ≧ 75). This is attributed to the greater physical activity of men in the earlier decades and a consequent inhalation of greater volumes of the dirt-laden air. Highest rates for every decade were found among residents in the dirty Loop area and in the areas adjacent to it on the west. With respiratory tract cancer death rates, the most significant finding was that the astonishingly high old-age male rates came on a full decade earlier in the most polluted sections of the city (rate of 252 at ages 60-69) than in the clean (rate of 239 and 246 at ages 70-74, 75 & over). There seemed to be no significant difference between clean and dirty districts in the final old-age rate attained, "except possibly for a slight indication of exhaustion of the supply of cancer-susceptible individuals at the older ages in the dirty areas."

Regional differences of sootfall within the city of Chicago showed fairly close correspondence with SO_2 concentrations in the air: concentrations of SO_2 - 0.40 ppm in the Loop, 0.27 ppm in the congested South Side residential areas and 0.10 ppm in the cleaner outlying residential areas; concentrations of sootfall - 160 tons/sq.mi./winter mo. in the Loop, 70 in the South Side and 20 in the outlying areas. In the author's opinion, this gives added significance to the correlation studies in which sootfall data were taken as the best index available of prevailing air pollution.

114. Pekárek, V.: Znečišťovani ovzduši hnědouhelné pánve Mostecko-Ústeke. (Pollution of the atmosphere in the soft-coal basin of Most-Usti.) Prac. lék. 4:339-45, 1952.

A preliminary study was carried out in the soft-coal basin of Most-Usti to ascertain the pollution of the atmosphere with both smoke and exhaust gases from plants. Attention was directed to finding macroscopic changes in the plants, especially in the forest vegetation. The SO_2 content of 253 air samples was determined. Simultaneously, wind directions and velocities as well as the air temperatures were recorded. In 5 areas in the soft-coal basin of Most-Usti, injurious effects of economic significance were found in plants which were especially pronounced with regard to forest growth. In some air samples collected during fog at a distance of several hundred meters from the source of contamination, the amount of SO_2 exceeded $25\gamma/1$. The investigation is being continued on the basis of the findings reported here.

115. Radcliffe, J.C.: The Greater Detroit-Windsor air pollution study. Part I--Industry's part. Am. Ind. Hyg. Assoc. Quart. 13:206-10, 1952.

A survey of the kinds and amount of fuel burnt and equipment used by industry was made. Next, a survey of the raw materials, products, effluents, height of discharge, etc., showed a lack of final data on the various processes in use in the area. The standard techniques and cooperative methods of sampling established for a stack sampling survey of all types of industrial processes are described. A training course in analysis of effluents, attended by industries' representatives, was held before the stack survey was started. This was just recently completed, and therefore little stack sampling data are available. From this it is hoped that appropriate control equipment will be designed and installed, thus reducing industries' contribution to the air pollution in that area considerably.

116. Stocks, P.: Endemiology of cancer of the lung in England and Wales. Brit. J. Cancer 6:99-111, 1952.

The death rates/million from cancer of lung and bronchus in England and Wales for 6 periods from 1911-1949 are tabulated by age groups of 25-, 35-, 45-, 55-, 65- and 75+ for both males and females. In 1911-20 certified mortality of men was about 1.7 times that of women, but the sex ratio increased steadily at each age group >35, until in 1945-49, it exceeded 7 at ages 45-65, and reached 4.7 at 35-44 and 65-74. In 1945-49, the rates for males reached 1412/1,000,000 for ages 55- and 1456/1,000,000 for ages 65-, as compared to 866 and 799, respectively, in 1940-44, and 61 and 72, respectively, in 1911-20. For females the rates were 196 for ages 55- and 307 for ages 65- in 1945-49; 140 and 205, respectively, in 1940-44; and 32 and 39, respectively, in 1911-20. The rates, in each case, decreased for ages 75+. Sex ratios in the County Boroughs and rural districts were ca. 2.5 in each area and did not increase at ages <35; but for ages 45-65 the ratio was considerably greater in town than in rural areas in 1921-39 and 1940-46, and it increased in both areas between the 2 periods. Although recent research has pointed to tobacco smoking as a very important factor in the causation of lung cancer, air pollution is also considered as a factor. An examination of lung cancer mortality rates for 1921-30 and 1946-49 in London and its Metropolitan Boroughs and in other large towns indicated a correlation of incidence of lung cancer with size of continuous urban area. Further analysis showed a general tendency for lung cancer mortality to increase with total number of chimneys, and thus air pollution, in towns with the number of dwellings <100,000; in larger towns, viz., London, Manchester, etc., the factor of density/acre seemed to be an important one. Taking all the County Boroughs separately, there was a correlation coefficient of 0.47 between lung cancer mortality and persons/acre. Consideration of wind direction as a possible factor led to the observation that in London during half the time

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Stocks, P. (continued)
the wind blows from the WSW. This would displace the pollution from the center towards the ENE section. The greatest cancer mortality has, in fact, been found to the ENE of the center of London. It is concluded that statistical investigation supported the hypothesis that atmospheric pollution by domestic smoke is an important factor in the genesis of lung cancer and that tobacco smoking superimposed on it is another. One carcinogenic substance might be common to both kinds of smoke, so that the smoking of 20 cigarettes a day in a large town might be more dangerous than a similar use of tobacco by one living and working in the country. It might be that the carcinogens were different but their effects additive.

117. Suia, J.: Anthracenové a benzpyrenové frakce z lidských tkáni. (Anthracene and benzpyrene fractions in human tissues.) Casopis Lékáru Ćeských 91:1029-33, 1952.

Anthracotic bronchial and lung lymphatic nodes of people who have died of cancer have been examined by means of fluorescence spectrography for the presence of 3:4-benzpyrene. The examination was undertaken on anthracosis originating in city-life and not in the mines. Unsaponifiable fractions were prepared from postmortem material; they were once more resaponified. Resaponified fractions were subjected to chromatographic separation on an Al_2O_3 column. Apart from other fractions, 2 fractions which showed UV light were obtained. Subjected to spectrographic analysis, these 2 fractions showed the presence of an anthracene and 3:4-benzpyrene spectrum. The fraction which provided a light blue fluorescence and which was easily washed out by an isoheptane-benzene mixture (9:1) showed an anthracene spectrum. The fraction which provided a dark blue fluorescence and which was eluted by an isoheptane-benzene mixture (1:1) showed a 3:4-benzpyrene spectrum. Previous biological and physiochemical experiments proving either an endogenous or exogenous carcinogen in the human organism were reviewed. Experimental results and theoretical considerations which led the author's working-hypothesis, i.e., to look for an exogenous carcinogen in the human organism and especially for 3:4-benzpyrene in anthracotic bronchial and lung lymphatic nodes were discussed in detail. (Author's summary.)

118. Waller, R.E.: The benzpyrene content of town air. Brit. J. Cancer 6:8-21, 1952.

Samples of suspended impurity collected daily at fairly central points in 10 cities in England, viz., Bilston, Bristol, Burnley, Cannock, Hull, Leicester, London (Beckton), London (County Hall), London (Crossness) and Sheffield, by an air-filter sampler were analyzed for benzpyrene. The method of identification is given in detail. The monthly concentrations of benzpyrene in air and its proportion in smoke at London County Hall, Sheffield and Cannock from May '49-June '50 are given. The seasonal values for summer (May-Sept.) and winter (Nov.-Mar.), the ratio of winter to summer values and the mean annual values from 1948-51 for each of the 10 cities are also given. A fairly well-defined yearly cycle was shown with a high monthly maximum in the winter and a low monthly minimum in the summer. Comparison of the proportion of benzpyrene in smoke also showed such a cycle, indicating that domestic coal smoke must be one of the chief contributors of benzpyrene to the atmosphere. The mean annual concentrations of benzpyrene in air in µg./100 m.^{3} were: London (County Hall)-4.6, Sheffield-4.2, Leicester-2.9, Burnley-2.7, Bilston-2.7, Cannock-1.9, Hull-1.8, Bristol-1.3. Beckton and Crossness were not centrally located. These results only indicated the condition close to each station and not necessarily those in the town

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Waller, R.E. (continued)
as a whole. Though the benzpyrene concentration increased considerably on very foggy days, the proportion of benzpyrene in smoke did not increase appreciably. Benzpyrene was also identified in the extremely fine sooty particles in the exhausts from a motor cycle, 2 cars and 2 diesel compressors. The range of sizes of these particles were thought to be quite near to the range which is most retained in the lung. Benzpyrene was not identified in cigarette smoke, though there was a possibility of its being lost in the method of separation.

119. West Virginia Department of Health, Bureau of Industrial Hygiene, and the Kettering Laboratory, College of Medicine, University of Cincinnati: Atmospheric Pollution in the Great Kanawha River Valley Industrial Area. Report prepared with consultation and assistance by the U.S. Public Health Service, Division of Occupational Health, 1952, 168 pp.

This report represents the results of a study of various atmospheric pollution factors in the Great Kanawha Valley during the period of February 1950 to August 1951. The area included in the survey extended from Glen Ferris to Nitro. The purpose of the study was to (1) establish factual information as to the air pollution problem of the valley; (2) determine the present or future needs of establishing an aggressive air pollution control program for the area and (3) compare the present particle-fall load of the valley to that of the period of a previous survey from June 1945 - Dec. 1947. No attempt was made to obtain factual data as to the influence of atmospheric contaminants on health, economy and vegetation. However, during the course of the study, the Department of Health sent to the practicing physicians of this area a questionnaire requesting their opinion, based on their observations, on the effects of air pollutants in the valley on the health of their patients. Of a total of 177 questionnaires sent 81 were returned with 73 being answered as requested, and 8 indicating that their limited practice did not qualify them to answer. Of those answering, 77% stated that in their opinion, there was an increased prevalence of bronchitis, rhinopharyngitis and sinusitis not associated with fever in the area in which they practiced, and they further attributed the etiology of these conditions to pollutants present in the atmosphere; 77% stated that, from their observations, they believed common upper respiratory diseases were induced, prolonged and aggravated by pollutants present in the atmosphere; 30% stated that they believed body system disturbances other than of a respiratory nature were attributable to air pollutants. The results of the 3,588 samples collected are reported. 28 particle-fall stations were maintained; 12 of them recorded an annual rate of 1,000 tons/sq. mi. or greater. This was shown to be fairly constant or increased in comparison with the 1945-47 survey, indicating that control measures were no more than keeping pace with increased industrial activity. Among the major contaminants, total S (as SO_2) ranged from 0-0.692 ppm in daytime samples; from 0-0.275 ppm in nighttime samples. Particulate matter ranged from 0.080-3.553 mg./m.^{3} in daytime, 0.087-1.277 mg./m.^{3} at night; chlorides (as Cl), from 0-0.216 ppm in daytime, from 0-0.173 ppm at night; NH_3, from 0-0.185 in daytime, 0-0.432 ppm at night; N oxides (as NO_2), from 0-0.30 ppm in daytime, 0-0.92 ppm at night; aldehydes, from 0-0.448 in daytime, 0-0.191 at night. Noticeable effects due to air pollutants, according to complaints, were that on May 12, 1950 the paint on many houses in the St. Albans area was markedly discolored (probably by H_2S); less severe discoloration occurred on previous occasions. On 2 occasions complaints of eye irritation, lasting until around noon, were received. On 1 occasion a distinct aldehyde-type odor was noted (concentration found at end of the period was 0.2 ppm). There were complaints of high particle fall during the night, especially on 2 occasions; also on numerous occasions, complaints of obnoxious odors were made, usually during the

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West Virginia Department of Health, Bureau of Industrial Hygiene, and the Kettering Laboratory, College of Medicine, University of Cincinnati. (continued)
nighttime. 2 particularly bad cases occurred in Kanawha City and in S. Charleston, the sources of which were not determined. These episodes were in addition to those known odors, e.g., sulfides and aldehydes, for which the source was known, and accidental release of odorous materials reported to the Department. The major pollution load of the area is believed to be of industrial origin, since very little coal is used for domestic heating. It is conceded that nonindustrial sources of pollution play a part in the over-all problem. Automotive traffic certainly adds to the total loading of the atmosphere with gaseous contaminants, even though it was impossible to correlate such findings with traffic density. Dust from unpaved streets caused a local air pollution problem, but it is doubted if dust etc. from paved streets can be considered a primary source of pollution, since a good portion of this is probably due to pollution deposited there from other sources. In general these various sources of pollution fall into the category of background pollution, the same as unavoidable losses to the atmosphere by the various industries.

120. Wichmann, H.J.: Report on metals, other elements, and residues in foods. J. Assoc. Off. Agr. Chemists 35:530-7, 1952.
The method for F, as adopted, mentions interferences from gelatinous SiO_2, Al, B, with no solution as to removal from SiO_2. Problems had arisen in several western states since the war in connection with F containing fumes emitted at first by new Al plants. The Food and Drug Administration was interested in the situation but could find little evidence of excess F in interstate foods coming from the areas and little or none in milk from F-intoxicated cows. Interference of SiO_2 in certain grasses, hays and pine needles, with resulting low F values by the A.O.A.C. method forces the reopening of the F question. It is therefore recommended that the Associate Refereeship on F determinations be reactivated with respect to this interference of excess SiO_2.

121. Clayton, G.D.: Determination of atmospheric contaminants. Am. Gas Assoc. Proc. 35th Ann. Conv., 1953:892-923.
This is a comprehensive paper of very technical character in which information on certain selected sampling equipment and analytical procedures currently used in air pollution investigations is assembled and tabulated. It is illustrated by 23 figures. In addition, a summary of results obtained by various air pollution studies, carried out both by the author and other investigators, in selected cities in the U.S. is provided, the results being tabulated in 10 tables.

122. Clayton, G.D. and Giever, P.M., with the assistance of Sitgreaves, R., Brinton, H.P. and Gafafer, W.: Report of Results of Sampling the Atmosphere in the Detroit River Area During 1951. International Joint Commission, Technical Advisory Board on Air Pollution, U.S. Section, 1953, 55 pp.
A reference signed Jan. 12, 1949 by the Governments of the U.S. and Canada requested a detailed study be made, on both sides of the international boundary in the vicinity of the Detroit River, to determine the sources, nature and amounts of atmospheric contaminants from combustion of fuels and industrial processes; the effects of meteorological factors on the dissemination and diffusion of atmospheric contaminants; the effect of atmospheric contaminants on health, vegetation, safety and economy and the necessary controls, their cost and by whom the costs should be borne. The actual field work was started on the U.S. side in

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Clayton, G.D., et al. (continued)
the spring of 1951. 28 census tracts were chosen in which the socioeconomic groups were classed: Negro with low, medium or high income; white high middle or low middle class, white high lower or low lower class. Air pollution in these areas was estimated visually as light, moderate, moderate to heavy, heavy or very heavy. The tracts were then paired according to similar socioeconomic status but different degree of air pollution. One high volume sampler was installed in each of the tracts, with 2 installed in 3 of the tracts, making 31 sampling points in all. The immediate location and the surrounding area of each of these points are described in detail. 32-43 samples were collected at each station during the period May 7-June 17, 1951. Thomas autometers were rotated weekly among the stations for the 6-wk. period. The sampling equipment, viz., high volume air sampler for particulate matter (PM), the standard impinger for Cl^-'s and F^-'s and particle size measurements, the midget impinger for particle counting, the thermal precipitator for particle size measurements and the Thomas autometer for SO_2, are described. The laboratory technics for determining the 24 metal constituents, Cl, F, and S content of the total PM, for dust counting and for particle size measurements are given.

Most samples for total PM weighed from 100-350 μg./m.^{3} air; a few weighed <50 or >750 μg./m.^{3} air. High and low median values for the 31 stations were 357.1 and 121.6 μg./m.^{3} air, respectively, a difference of 235.5 μg./m.^{3} air. Differences ranging from 290->900 μg./m.^{3} existed between maximum and minimum values at each station, thus indicating a greater variation at any 1 location than between the stations. Highest median values for PM were located close to the Detroit River in S and SW Detroit and near Hamtramck in the center of Detroit. Lowest median values were found in residential areas removed from local sources of air pollution. The relationships of the average daily total weight of PM of all stations to the individual stations are plotted and show that daily variations in loading at each station followed the trend of the average for all stations very closely, with those stations having the highest median values also showing the greatest deviation from the average. The weight of total PM and of each metal collected by day and station, and the frequency distribution, median, maximum and minimum figures for the 20 elements are tabulated in appendixes I and II. Al, Fe, Si and Ca, with median values of 2.7, 2.4, 2.4, 2.1 μg./m.^{3}, predominated in the suspended matter. Mg, Ni, Cu, Zn, Mo, Cr, Mn, Ba, Pb, Sn, Ti, Cd and V ranged from 0.002-0.7 μg./m.^{3}, and Sb, Co and Be had "absent" median values. F^-'s and Cl^-'s varied from 2.65-7.35 μg./m.^{3} when collected by impinger; the values varied from 0.39-0.95 μg./m.^{3} when determined from the PM collected by the high volume air sampler. The differences are assumed to be caused by the presence of gaseous F^- and Cl^- compounds in the atmosphere. The average dust count by light field technics was 0.7 MPPcf. No relationship between total weight and dust count was observed. The mean particle size of the dust was 0.94 μ. Loadings of PM were below average when the wind was from the NE (usually accompanied by cold air masses causing greater stability near surface). Precipitation occurred whenever minimum PM concentrations occurred, but it sometimes occurred with high pollution also. Maps showing the correlations between total PM, wind speed, wind direction and sources of pollution at each of the 31 sampling sites are included. The data indicated that sources of heavy pollution within a 1 mi. radius of the site influenced the weight of the sample obtained. These maps also indicated heavily traveled streets, school yards and residential activities as well as industrial operations to be sources of pollution. Two Thomas autometers were moved from 1 sampling station to another at approximately 2-wk. intervals throughout 1951; 10 more were used from May 7-June 17 and moved at 1-wk. intervals. No correlation could be found between total PM

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Clayton, G.D., et al. (continued)
and SO_2 concentration. Approximately 70% of the SO_2 readings were <0.10 ppm. Highest average SO_2 concentrations and more marked diurnal peaks occurred in the winter. In high pollution areas, higher concentrations of SO_2 occurred in the morning hours (7 a.m.-9 a.m.) during the winter season, and in the evening (7 p.m.-10 p.m.) during the summer season. No relationship between cyclic weekly industrial activity and SO_2 concentrations could be determined. The highest concentrations occurred on week ends (Friday, Saturday or Sunday). The conclusion drawn was that no contaminant can be isolated as an index of total pollution in the area. 24 tables, 2 graphs, 46 figures, 1 illustration and 26 maps are included.

123. Clemmesen, J., Nielsen, A. and Jensen, E.: The increase in incidence of carcinoma of the lung in Denmark, 1931 to 1950. Brit. J. Cancer 7:1-9, 1953.

The increase in mortality from cancer of the lung among men in Denmark, i.e., from 128.8/10,000 in 1936 - 140.8 in 1940 - 342.6 in 1950, has been demonstrated to be mainly due to a real increase in incidence of the disease, although a slight accentuation of the increase during the years following 1940, which can be demonstrated for both sexes, must be explained as due to improvements in diagnostic means. An analysis of the increase in mortality rates on the basis of cohorts shows that the differences in crude mortality rates for cancer of the lung between Copenhagen, provincial towns and rural areas may be ascribed to a delay in onset of the carcinogenic influence of about 8 years for provincial towns and of about 10 years for rural areas. Thus there is no reason to assume any carcinogenic influence of atmospheric pollution as far as Denmark is concerned. Under the supposition that the carcinogenic influence does not begin earlier than about the 15th year of age or a few years later, the authors are led to believe that under the conditions as in Copenhagen, it takes at least about 20 years from the beginning of the exposure to the carcinogenic agent till the death of the patient. Under these assumptions the carcinogenic factor in Copenhagen must have begun to exert almost full influence about the period 1900 - 1910.

124. Committee on Air Pollution (Beaver, Sir H., Chairman): Interim Report, London, H. M. Stationery Office, 1953, 32 pp.

Part I - Outline of the Problem and Recommendations for Immediate Action

The main sources of air pollution are smoke from the incomplete combustion of fuels, the oxides of S emitted from either complete or incomplete combustion, fine dust and grit. Smoke from domestic sources is the greatest offender and the hardest to control. Industrial sources can, and in some cases have been, greatly reduced. Measures should be taken to warn the public of approaching fog conditions, at which time the public, especially the householder, should use smokeless fuels if possible or, at least, control fires to give as complete a combustion as possible and do no unnecessary burning.

Part II - A More Detailed Technical Survey

The polluting substances from combustion sources are particles of C or soot, coal, coke, smoke and ash, tarry matter, volatilized hydrocarbons, CO, SO_2 and SO_3 mist. The concentration of these materials becomes most important during fogs, the combination making the smogs. The inland consumption of solid fuel by class of consumers in 1952 is tabulated; it shows a total consumption of 204.7 million tons of coal (151.6 million tons burned directly). The inland distribution of petroleum products is also tabulated. The total pollution from solid fuel and oil is 2.1

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Committee on Air Pollution (Beaver, Sir H., Chairman). (continued)
million tons of smoke, 0.6 of grit, 5.3 of SO_2, 0.3 of other acids (HNO_3 and HCl) and 24.0 of CO.

The effects of air pollution on health in the smog of Dec., 1952 were very harmful. Some 4,000 people are estimated to have died from the "smog," and the increase in number of deaths was greater than for any other fog. A clear correlation between the pollution by smoke and SO_2 and the daily death rate in Greater London at that time is illustrated graphically. It is also thought that some carcinogenic substance in smoke may be partly causing cancer of the lung.

The economic loss from smog is roughly estimated at £100-150 million/yr. in material damage to property, labor for such repairs, extra cost of artificial lighting, damaged health and wasted fuel in incomplete combustion.

There are several statutory provisions in force in both England (mainly the Public Health Act, 1936) and Scotland against smoke, dust and effluents. Other legislation for the control of pollutants from railways, coal mine refuse, road traffic and alkalie works are also in force.

The preventive measures that have been or are being taken are:
(1) The conversion of bituminous coal into coke, gas and electricity.
(2) The use of smokeless fuels for domestic purposes in place of bituminous coal.
(3) The replacement of old-fashioned domestic grates by improved appliances in which smokeless solid fuels, and if necessary bituminous coal, can be burnt with appreciably greater efficiency.
(4) The extension, where economic, of central or district heating, whereby blocks or groups of buildings are heated from a single smokelessly fired boiler.
(5) The promotion of greater fuel efficiency in industry, both by more competent use of existing equipment and by the modernization of present equipment or the installation of new equipment where needed.
(6) The use of efficient grit-arresting plant for furnaces fired by pulverized fuel or operated by forced draught.
(7) The cleaning of coal at the coal fields to remove shale and some of the S compounds.
(8) Research and development work on practicable methods of removing SO_2 from the flue gases of power stations and other large boiler plants.

125. Cooper, R.L.: Atmospheric pollution in Salford. Chemistry & Industry 1953: 1364-5.
For abstract, see article published in Analyst 79:573-9, 1954.

126. Council for International Organizations of Medical Sciences, Clemmesen, J. (ed.): Symposium on the Endemiology of Cancer of the Lung. Session held at University of Louvain, Belgium, 1952, July 21-24. Acta Unio Intern. contra Cancrum 9:437-636, 1953.
This symposium includes the following papers:
Steiner, P.E.: Etiological implications of the geographical distribution of lung cancer, pp. 24-49;
Smith, W.E.: An evaluation of claims for occupational factors in cancer of the lung, pp. 50-8;
Kennaway, E.L. and Waller, R.E.: Studies on cancer of the lung, pp. 59-68;
Doll, R.: Smoking and carcinoma of the lung, pp. 69-80;
Hammond, E.C. and Horn, D.: Tobacco and lung cancer, pp. 81-5;
Stewart, H.L.: Pulmonary tumors in animals with particular reference to mice, pp. 86-102;
Korteweg, R.: Some remarks on the age curve in lung cancer, pp. 103-4;
Levin, M.L.: The occurrence of lung cancer in man, pp. 105-14;
Kretz, J.: Cancer of the lung in Vienna, pp. 116-25;

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Council for International Organizations of Medical Sciences, Clemmesen, J. (ed.).(continued)
Dorn, H.F.: Morbidity and mortality from cancer of the lung in the United States, pp. 126-35;
de Muylder, C.: Une opinion belge sur la fréquence et l'étiologie du cancer primitif des bronches. (A Belgian view of the frequency and etiology of primary bronchogenic carcinoma), pp. 136-46;
Denoix, P.F.: Les cancers broncho-pulmonaires en France entre 1946 et 1951. (Broncho-pulmonary cancer in France, 1946 to 1951), pp. 147-53;
Neurdenburg, M.G.: Some statistical information on cancer of the lung in the Netherlands, pp. 154-62;
Korteweg, R.: On cancer of the lung in the Netherlands, pp. 163-71;
Kreyberg, L. (presented by K. Arnesen): A survey of the histological types of one hundred primary epithelial lung tumours in Norway, pp. 172-6;
Clemmesen, J., Nielsen, A. and Jensen, E.: Mortality and incidence of cancer of the lung in Denmark and some other countries, pp. 177-210.

127. Doll, R.: Bronchial carcinoma: Incidence and aetiology. Brit. Med. J. 2:521-7, 585-90, 1953.

The results of many epidemiological studies of lung cancer are reviewed. The crude annual death rate from lung cancer in England and Wales was found to have risen from 8/million in 1900 - 20 in 1925 - 278 in 1950. Of all cancers in men, lung cancer occurs the most frequently, i.e., 24% of all cancers; it is 2nd only to the stomach cancers in both sexes and it is much lower in women. Of all male deaths in 1950, 4% were attributed to lung cancer. Only a small part of the increase in incidence can be attributed to the increasing proportion of the population living to the cancer age or to improved diagnostic methods. Some of the experiments with animals are reviewed; the results are not found to be directly comparable to those obtained from human beings. In 1949 the highest death rates from respiratory cancer/million persons were 288 in England and Wales, 256 in Scotland, 131 in the U.S.A. and the lowest were Spain 67, Iceland 80, Norway 63 and Chile 47. Though the incidence of lung cancer is different in various parts of the world, every country recording vital statistics of respiratory cancer reports a substantial increase in the death rate from bronchogenic carcinoma. Most cases occur in urban centers; in 1950 the death rates from bronchogenic carcinoma in men was twice as high in Greater London as in rural areas. Rates among women showed similar trends. This has also been reported in Denmark and Norway. Three carcinogens have been identified in town air, i.e., radioactive material, As_2O_3 and benzpyrene from the smoke of domestic fires and detectable amounts from auto exhausts, but the amounts of each are variable and below the tolerance concentration; that of benzpyrene, however, may be greatly increased in winter and during fogs. Occupational risk of lung cancer is high in the mining of Ra-containing ores, chromate production, Ni refining, asbestos manufacture, production of gas, handling of inorganic As or exposure to Fe or SiO_2 dust. In all countries the higher the incidence of the disease the greater the male preponderance, which is 6-7:1 in Britain and 1.3:1 in Norway. Investigations in 4 countries suggest that tobacco smoking may cause bronchogenic carcinoma, though no known carcinogenic agent has been detected in tobacco smoke. Pipe smoking, with 1 exception, has been less closely associated with bronchial carcinoma than cigarette smoking. Users of cigarette holders and filter-tipped cigarettes have been less frequent among lung carcinoma patients than among patients with other diseases, and these devices may remove the active agent before it reaches the respiratory tract. The length of the latent period before the tobacco factor exerts its effect is not known. The higher mortality in urban

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Doll, R. (continued)
areas from bronchogenic carcinoma may be explicable on the grounds that cigarette smoking is heavier in these areas. Arsenic may not be the responsible agent since there is a high prevalence of lung cancer in Istanbul, although Turkish tobacco contains little if any As. There is no evidence to implicate exhaust fumes from cars or road dust as carcinogenic agents, or that previous attacks of bronchitis, influenza, pneumonia or other respiratory disease play any part in the etiology, nor does there appear to be any hereditary predisposition. (89 references.)

128. Elmes, P.C., Kay, K. and Fletcher, C.M.: Sputum in chronic bronchitis; Effects of antibiotics. Lancet II:903-6, 1953.

The exacerbations of chronic bronchitis in autumn are probably due to further damage to epithelium of the lower respiratory tract by virus infections or by atmospheric irritants which create conditions favoring proliferation of organisms from the upper tract. During exacerbations, polymorphs and fibrous nucleoprotein tend to increase and the sputum to become purulent. This seemed to occur when exacerbations were due to "colds" or fog as well as when due to pneumococcus or H. influenzae.

The association between purulence and fog was suggestive but not significant. The effect of fog on sputum when H. influenzae is absent and present is shown by:

H. influenzae	Fog	Total No. of sputa analyzed	P*
Absent	Present	75	0.7 - 0.5
	Absent	145	
Present	Present	51	0.02 - 0.01
	Absent	90	

*P - index of probability (test of significance)

Fog, therefore, increased the purulence of sputum significantly only in patients with H. influenzae in sputum.

Penicillin, aureomycin, chloramphenicol and sulfadimidine given orally were not suitable for prophylaxis of acute attacks.

129. Ely, S.B., Supt.: 1952 Report of the Bureau of Smoke Prevention, Pittsburgh, Pa., Department of Public Health, 1953, 19 pp.

A digest of the Pittsburgh Smoke Ordinance No. 344 is given. The reduction of hours of total smoke in 1953 over 1946 is 69.4%, of heavy smoke - 94.4%. Dustfall collected in 11 cans showed an average of 50.7 tons/sq.mi./mo. throughout Pittsburgh. A criticism of the can records is included. Cans are more or less a measure of weather conditions. Further, health is often more affected by fine particles, rather than by the large ones which contribute more to the weight in the cans. Actually the over-all averages for '51, '52 and '53 show little differences in values. Though the results of the electrostatic precipitator are graphed, the values are not considered very reliable as not enough continuous samplings were obtainable. However, this method has the advantage of collecting finer particles than the cans do. Spectrographic analysis of the can deposits gave 20.11% SiO_2, 20.42% Fe_2O_3, 8.32% Al_2O_3, 2.32% MnO, 1.76% MgO, 4.58% CaO, 0.06% ZnO, 0.13% Cr_2O_3 and 0.05% SO_3. The inspectors' reports and the Pittsburgh railroads report are also included.

130. Hoffmann-Axthelm, W.: Beobachtungen über den Einfluss des Fluors auf Zahnschmelz und Schilddrüse. (Observations on the influence of fluorine on dental enamel and thyroid gland.) Deut. zahnärztl. Z. 8:757-65, 1953.

The occurrence of mottled enamel in Berggiesshübel, Saxony, was investigated by the author in 1952. The community is supplied by 5 springs with F content ranging from traces to 2.2 mg./l. Of 298 children examined, 81.46% of the native-born had mottled enamel, and 54.49% were caries-free; of those

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Hoffmann-Axthelm, W. (continued)
that had migrated to the region, 20.34% had mottled enamel, and 39.45% were caries-free, compared with Berlin survey (1937-1945) of 10,587 children showing 34.5% to be caries-free. The variations of mottled enamel in the 2 zones of the community, and the fact that the older generation was free from it, could not be correlated with the F content of the drinking water. The difference was attributed to the F factory in Dohna, situated 11.2 km. from Berggiesshübel in the direction of prevailing wind. It is believed that the food grown in the region also has increased F content. No concentrations of F in food and water supplies are given. A decreased incidence of goiter was observed in the F region, compared with F-poor regions.

131. Larson, G.P.: Air pollution control in Los Angeles. Modern Sanitation 5, No. 7:23-5, 68, 1953.

The smog mixture in Los Angeles consists principally of dusts, smoke, condensed fumes, oil mists, peroxides, aldehydes, organic acids, SO_2, N oxides and certain hydrocarbons; these are grouped into aerosols, and gases and vapors. The aerosols, mainly the ether-soluble aerosols, H_2SO_4 mist and dusts, are listed in order of decreasing ability to reduce visibility. The individual components of the gas or vapor phase are also listed; they are predominantly hydrocarbons, easily undergo photochemical reactions in the air and are responsible for eye, nose and throat irritation and damage to vegetation. The results to date of the Los Angeles control program are summarized. The total daily emission of pollutants has been decreased by 600 tons. In particular, S is being recovered from 360 tons SO_2/day; this represents a 50% reduction in SO_2 emission. Dusts, fumes and other aerosol emissions from various industries have been reduced by 70 tons/day. Refinery losses of gasoline have been cut by 100 tons/day. The emission of 60 tons of smoke, 50 tons of organic acids and 10 tons of aldehydes from combustion processes has been eliminated. The number of days of dense smog has been decreased and visibility increased. Although the present control program is effective, new sources of pollution are arising faster than they can be handled and will require more research. The many fields which need further study, e.g., air pollution zoning program, micrometeorology, rubbish disposal, either by conservation or combustion, physiological effects of air pollution and control of gasoline vapor and auto exhausts, are discussed. A large number of other projects that are currently being studied are reduction of SO_2 from coal and oil burning equipment, improved fly ash collectors, basic studies on filter media, analytical methods and instrumentation.

132. Larson, G.P., Fischer, G.I. and Hamming, W.J.: Evaluating sources of air pollution. Ind. Eng. Chem. 45:1070-4, 1953.

Methods for determining the quantities of the various pollutants emitted within an area are presented and these emissions are discussed in relation to air sampling data. The tables presented include: (1) concentrations of pollutants in Los Angeles atmosphere during periods of good visibility and of intense smog; (2) losses of materials to atmosphere in relation to the quantities of material processed or consumed; (3) field test data on the emission of nonether-soluble particulates; (4) daily production and consumption of combustible material in Los Angeles County, 1951; (5&6) 1951 petroleum refinery and marketing hydrocarbon losses/day and (7&8) emissions to Los Angeles County atmosphere of aerosols, acid gases and aldehydes and of hydrocarbons by source for 1940, 1948 and 1951. Concentrations of pollutants in downtown Los Angeles, 1951 are calculated for periods of good visibility and of intense smog,

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Larson, G.P., et al. (continued)
and compared with the measured values. Good agreement is found for N oxides and SO_2, while calculated values are much higher for total hydrocarbons and much lower for organic acids and lower aldehydes. This is interpreted as confirming the oxidation of hydrocarbons to aldehydes and acids, whereby the concentration of the former would be reduced and that of the latter increased. Aerosols are evaluated in terms of their ability to reduce visibility. This is determined by means of a relative pollution index (R.P.I.) for each material which is based upon the radius of the aerosol particle involved, its index of refraction and the quantity.

The build-up of pollution from 1940-1948, the technological changes contributing to this build-up and the reductions in pollution that occurred from 1948-1951 are discussed. Of particular importance were the increased release of unsaturated hydrocarbons to the air from expanded refining activity and greater gasoline consumption, and the use of catalytic cracking which forms more branched-chain paraffins than thermal cracking. These branched-chain paraffins form stable peroxides in sunlight which increase the rate of oxidation of olefins. The scope of future control measures is indicated. (17 references.)

133. **Leclerc, E.:** A propos de la détermination du degré de pollution de l'atmosphère des villes, (On the determination of the degree of atmospheric pollution of city atmosphere). Rev. universelle mines 9:801-8, 1953.

The amount of atmospheric dust in Belgium was measured by means of impaction on Al spheres (12 cm. in diameter) covered with a layer of pure vaseline, and placed on poles 3 m. high, in rural areas, city centers and near industrial plants. After suitable exposure, the spheres were carefully washed with a vaseline solvent (petroleum ether), filtered (Gooch crucible), dried (110° C.) and weighed. The periods of exposure were of sufficient duration and covered the most characteristic periods of the year. The mean values obtained were:

Country	1.5 mg./day
City center	6.0 mg./day
Neighborhood of plant (coke ovens)	20.0 mg./day

This method was compared with the English method of collecting the dust by means of a funnel (ca. 30 cm. in diameter) in which the dust and rain and snow fall are washed down into a flask, both devices being placed in the same location. Though each method has its limitations, the results were considered to be comparable, but not identical.

SO_2 was collected by exposing to the atmosphere for a suitable time a tissue impregnated with an alkaline solution (glycerine, H_2O and $NaHCO_3$) and wrapped around a flask. After exposure, the tissue was then analyzed for sulfates and sulfites. Blank runs yielded small amounts of $BaSO_4$ which could not be accounted for. On comparing this method with the English method (SO_2 absorbed by a layer of PbO_2 on a porcelain "candle"), the author's results were found to be proportionally higher.

The values for both dust and SO_2 in various localities varied greatly, e.g.:

	dust	SO_2
Highly industrial town (Seraing)	22 mg./day	7 mg./day
Center of Liège	5-10 "	5 "
Flône	0.7 "	0.8 "

The results in England were analogous.

It was found that, in general, the atmosphere was more polluted in winter than in summer, though there were exceptions, especially in industrial areas. This was also observed in Germany. Pollution was also found to vary inversely with altitude.

134. Lykova, A.S.: (The role of motor vehicle exhaust gases in contaminating the atmosphere of large cities.) Trudy Leningrad. Sanit.-Gigien. Med. Inst. 14:89-102, 1953.

The CO content of air samples taken from various locations in large Soviet cities, i.e., on and near highways, in residential areas and in industrial area remote from major highways, at various times of day is correlated with density of adjacent automobile traffic. Samples taken in pedestrian breathing zones had CO content (mg./m.^{3}) ranging from 4 to 164 (0.003 to 0.1312 ppm), averaged ca. 6 with fewer than 1000 cars/hr., 13 at 1000-1500 cars/hr., 25 at 1500-3000 cars/hr. and reached maximum values at service stations. CO concentration in residential areas having motor transport was greater than in industrial areas without motorized transport. CO was more frequently detected and concentrations were higher in the winter. The "average" CO content of Soviet cities (17.8 mg./m.^{3}) is much less than corresponding values ascribed to certain other cities (75 for Chicago and 126 for Paris in 1928, 100-318 for the U.S.A. in 1925-28). Traffic control personnel show higher blood CO hemoglobin content (as compared with people not exposed to air containing continual low-level CO) sufficient to account for general complaints of headaches and dizziness as being due to chronic CO intoxication. Erythrocyte count, hemoglobin content and O_2-capacity data are included for the test personnel. (CA 49:9847, 1955.)

135. Munroe, W.A.: New Jersey State Department of Health Air Sanitation Program. Paper presented before the American Industrial Hygiene Association, New Jersey Section, October 15, 1953. (Also presented at Air Pollution Symposium, Wagner College, March 1954, 8 pp. Public Health Repts. (U.S.) 69:726-8, 1954.)

The air sanitation program in New Jersey is part of the Bureau of Adult and Industrial Health and seeks to preserve or restore by medical, engineering and legal means an outdoor atmospheric environment sufficiently free of contaminants so that the optimum health, comfort or general well-being of the public is maintained. The forms of air contamination considered are: chemical pollutants from industrial processes; smoke from industrial or domestic facilities; smoke from industrial or municipal incinerators or dumps; exhaust gases from motor vehicles; objectionable pollens and miscellaneous forms of man-made or natural contamination. Since the philosophy of the Department is to place most of the responsibility for public health activity on local officials, the main objectives of the program are (1) to assist in the establishment of local control, both technical and legal; (2) to carry out air sanitation research in air sampling and testing methods and field studies and (3) to provide technical assistance to municipalities and industries. Definite legal control is available in State Public Health Law if, or when, an air sanitation problem becomes a health hazard.

136. Oswald, N.C., Harold, J.T. and Martin, W.J.: Clinical pattern of chronic bronchitis. Lancet II:639-43, 1953.

A questionnaire was completed on 1000 patients with chronic bronchitis to determine the age at and mode of onset, age at onset of breathlessness, degree of breathlessness, character of sputum, severity of clinical symptoms, radiological findings, effect of climate, occupation and living conditions. Also, a comparison was made between 300 of these and 300 comparable controls in relation to family history, respiratory disorders of childhood, allergic diseases, colds in the head, smoking habits and blood pressure. It was found that chronic bronchitis is largely a disease of middle-aged men. The disease occurred in 11.4% of the relatives of the patients as compared to 3.8% of those in the controls. Chronic or recurring respiratory infections in childhood were much more common in patients than in controls.

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All patients were specifically asked which atmospheric conditions adversely affected their bronchitis; affirmative answers were fog 744, wet 698, cold 435, hot 62 and dry 20. In addition, symptoms were aggravated in 440 on suddenly going from a hot to a cold atmosphere, and 174 on going from cold to hot. There were appreciably fewer nonsmokers among the 300 patients than among the controls, the figures being 27 (9.0%) and 62 (20.7%), respectively. The mean daily number of cigarettes was 18.2 among the smokers and 16.7 among the controls. The principal factors at work which the patients considered as aggravating their bronchitis were changes in temperature and draughts (175), dampness (148), cold (132), dusts (129), smoke and fumes (111) and contracting infections from contacts (83). More than half of the dusts incriminated were related to houses, coal, books and papers. Others included wood shavings, packing materials, upholstery, paint and flour. Almost any dust seems to be a potential irritant. Possible irritants, e.g., asbestos, cement, cork, wool, lead, lime, marble, printers' ink, talc and chromium, caused the patients to seek work elsewhere. Fumes and smoke were another potent source of bronchial irritation. The products of combustion of coal were mentioned most frequently. Some 51 males, aged 51-69, were exposed to gas in the 1914-18 war; 27 of these dated the onset of their bronchitis to gassing, and most of the remainder thought it aggravated their bronchitis, although sometimes the onset was many years later. Among other irritants were exhausts from motor cars, H_2SO_4, acetone, benzene, caustic soda and paint spraying. In the discussion it was noted that infection was considered to have been present at the onset of respiratory symptoms in every case, but that other factors, e.g., climate, atmospheric impurities and hereditary predisposition, undoubtedly played a part.

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137. Peart, A.F.W. and Josie, G.H.: Some considerations in planning a comprehensive study to determine the effects of air pollution on health. A review of methodology. Arch. Ind. Hyg. and Occupational Med. 7:326-38, 1953.

An investigation of the Detroit River area was being carried out by the Technical Advisory Board on Air Pollution of the International Joint Commission in an attempt to study the effects of air pollution on health. The basic considerations of such a comprehensive study, which are discussed very generally, were applied practically by this investigation. Two general approaches were used: (1) a review of existing health data in the Detroit River area for comparison with other cities and (2) the conducting of a sample morbidity survey in the area to measure and compare the intensity and types of sicknesses and symptoms in well-defined areas of high and low pollution. A review of the existing health data included consideration of mortality statistics, hospital and medical care records, industrial and school records, communicable disease reports and others. For the sample morbidity survey, paired sample areas were selected and matched according to socioeconomic factors with 1 a high pollution area and the other a low pollution area. Two such pairs of matched areas (1 of white population and the other colored) were selected in Detroit and 1 pair (white population) was selected in Windsor. Control areas with the same socioeconomic factors but with no air pollution were selected in the same vicinity.

The amount of pollution in the various areas throughout Detroit and Windsor was determined by analyses of samples collected daily for 6 weeks in 28 census-tract areas in Detroit and at 25 stations in Windsor. The median, maximum and minimum concentrations (in $\mu g./m.^3$) of the metallic elements detected (Si, Ca, Al, Fe, Mg, Pb, Mn, Cu, Zn, Ti, Sn, Mo, Ba, Ni, V, Cr, Cd, Be, Sb, Co) are listed for Windsor and for Detroit; wide ranges between the maximum and minimum values are noted. SO_2 analyses were also run; median concentration in the U.S. area was 0.046 ppm, while that in the Canadian area was 0.023 ppm SO_2. It was planned that ca. 1,000 households, 500 in Detroit and 500 in

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Peart, A.F.W., et al. (continued)
Windsor, would be visited for the morbidity survey. The data would be based largely on a statement of illness by the informant (housewife generally), and the accuracy of the lay statements would be determined by a physician's diagnosis where possible. Refinements in methods would be added as the survey progressed. A careful assessment of initial health status at the start of the study was also made. Special groups, e.g., infants, asthmatics, persons with cardiac disease, etc., who were likely to be more sensitive to air pollutants would be more carefully studied. The records kept included (1) a household record card which contained general family and environmental data, (2) a record of present health status, including preexisting conditions, (3) an individual sickness record and (4) a supplementary sickness record. From this investigation, it was hoped that a reliable index of air pollution and an equally reliable health index might be discovered.

138. Pemberton, J.: Bronchitis and broncho-pneumonia in an industrial community. Trans. Assoc. Ind. Med. Officers 3:202-9, 1953.
Bronchitis and bronchopneumonia account for ca. 8% of all deaths, i.e., 40,000,annually in England and Wales; these diseases also cause much illness with progressive disability. The death rates/million from both are tabulated by sex and age; a high rate, especially for bronchopneumonia, occurs for both sexes at ages 0-1 and 1-5, and then again in the older age groups. The rate for bronchitis in males is 685/1,000,000 at ages 50-55 up to 14,306 at 85+; in females it is only 167 at 50-55 up to 10,081 at 85+. For bronchopneumonia in males the rate is 692 at ages 65-70 and 5,725 at 85+; in females, only 353 at 65-70 and 4,503 at 85+. The effect of urbanization on incidence is shown by a comparison of the notification rates for acute lobar pneumonia and influenzal pneumonia for 1949, viz., 10.7/1,000 in the county boroughs, 6.9 in the urban districts and 7.1 in the rural districts. It has been assumed that industrialization is responsible for the high incidence of these diseases in county boroughs, since the boroughs are 71% industrialized. Sickness absence records in 4 steel works showed bronchitis accounted for 13% of all medically certified illnesses in the 6-month period, Jan.-June, 1949. The mortality rates/ 1,000,000 for industrial, semi-industrial and nonindustrial county boroughs for bronchitis are 79, 54 and 56, respectively, and for pneumonia, 52,42 and 41, respectively. Some of the possible causes of the higher incidence that are discussed are climatic factors, social factors, overcrowding, nutrition, atmospheric pollution and occupational factors. A comparison of mortality rates for the rural areas in the N and the SW show little difference, although the rates for each area as a whole show a greater incidence in the N, which is more heavily industrialized. Further, statistics from other parts of the world show the relative unimportance of cold climate. Though the average death rate/month is greater during the winter months, this is probably due to greater prevalence of the common cold and influenza in the winter and to increased exposure to such infections from more indoor living. A comparison of the S.M.R.'s (Standardized Mortality Rates) for the 5 social classes shows that the SMR for bronchitis in males in Class V (unskilled laborers) was 5 times that of Class I (professional and managerial), with a steep gradient through the intermediate occupational classes. For pneumonia, the gradient was similar but less steep. For married women the social class gradient was also marked. The most likely causes for this are overcrowded living conditions, poor diets, atmospheric pollution and industrial occupation. Exposures in acute episodes of air pollution clearly show acute effects, especially in the elderly. It is more difficult to determine the part played by long

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Pemberton, J. (continued)
exposure to lesser degrees of atmospheric pollution in the genesis of bronchitis and bronchopneumonia. Out of 198 occupations listed, 15 occupations involving exposure to dust, especially SiO_2, and to high temperatures have the highest SMR's ranging from 733-197.

139. Scott, J.A.: Deaths and sickness in London in December, 1952. Appendix A. In: Report of the County Medical Officer of Health and School Medical Officer for the Year 1952. London, London County Council, 1953, pp. 151-63.

Deaths registered and the First Certificates for Sickness Benefit have proved to be a sensitive index of widespread changes in morbidity during the winter. These were utilized in assessing the effect of the Dec. 1952 fog on health. In Nov. 1952 there was a slightly higher incidence of sickness in London which continued with a slow increase into December. For the week ending Dec. 2, 11,678 sickness benefit claims were registered and for the week ending Dec. 9 (during which the fog occurred) there were 12,553 claims. For the week ending Dec. 6, 945 deaths were registered in London. On the basis of the relationship of sickness benefit claims to deaths experienced in the period of Oct. 14 - Dec. 6, 1952, from 890-1,270 deaths would have been expected for the week ending Dec. 13. Instead, 2,484 deaths were registered. Similar, but smaller, increases in the removals of in-patients to hospital by ambulance and Emergency Bed Service applications were noted. A day-by-day account of certain aspects of the weather, of pollution and of sickness and deaths in the County of London from Dec. 1-10 is given. The mean air temperature at Kew Observatory was 2-3° below freezing from Dec. 5-8; average smoke concentration reached a peak of 4.46 mg./m.^{3} and SO_2 - a peak of 1.339 ppm on Sunday, Dec. 7 - Monday, Dec. 8. The deaths started to increase with great rapidity during the fog; even on the 1st day of fog, Dec. 5, there was an obvious increase which mounted to the highest level on Dec. 7-8. Some decline occurred on Dec. 9 which continued the next several days; but even on Dec. 15, the daily total was almost twice as high as before the fog began. The morbidity did not reach such a peak or fall off as rapidly. There were considerably more people lying ill, especially with respiratory complaints, the week after the fog than during the 4 days of fog itself. The number of deaths/week from the week ending Nov. 22 - Dec. 27 are tabulated by age and by certain causes and each of the latter 3 weeks compared with the average of the 1st 3 weeks. The sudden increase, although most pronounced among babies ($\leqq$ 1 year) and the elderly (>55), a 250-300% increase, was not confined to people of any particular age. According to cause, "compared with the average/week in the previous 3 weeks, deaths from bronchitis in the week ending Dec. 13 were 10 times as many, from influenza - 7 times, from pneumonia - nearly 5 times, from pulmonary t.b. - 4 1/2 times, from other respiratory diseases - nearly 6 times, from cancer of the lung - nearly 2 times, from disorders of the heart and circulatory system - nearly 3 times." Comparison of mortality increases during the fogs of Dec. 1873 and Feb. 1880 were also made.

140. U.S. National Bureau of Standards: Maximum permissible amounts of radioisotopes in the human body and maximum permissible concentrations in air and water. Natl. Bur. Standards Handbook No. 52, 1953, 43 pp.

Table 3, giving the maximum permissible amount of radioisotope in total body and maximum permissible concentration in air and H_2O for continuous exposure (Oct. 1951), includes 3 types of elements - common radioisotopes that are α-emitters, β- and γ-emitting radioisotopes that are of interest because they are common body elements and other radioisotopes of current interest - the critical organ and the maximum concentration as μc. in total body, μc./ml. H_2O and μc./ml. air. Table 4 lists the constants for calculating maximum permissible internal concentrations of radioisotopes, and the general equations for these calculations are given.

141. Bell, C.G., Jr., Thomas, H.A., Jr. and Rosenthal, B.L.: Passage of nuclear detonation debris through water treatment plants. J. Am. Water Works Assoc. 46:973-86, 1954.

Approximately 2,200 samples taken in the various treatment stages of 3 water plants were measured for β, γ radioactivity to assess the health hazard associated with the presence of radioactive fallout due to nuclear detonation in municipal water supplies in N.Y. and Mass. All plants employed alum coagulation and rapid sand filtration. The respective water sources were a system of small reservoirs, a river and Lake Ontario. From these measurements, it was found that, within about 2 weeks after a nuclear detonation, approximately 45% of the gross long-range fallout radioactivity entering passed completely through rapid sand filtration plants. From 2-10 weeks after detonation ca. 53% passed through the plants. For periods beginning at least 10 weeks after detonation, practically all the radioactivity (partially of natural origin) passed through the plants. In every instance, the removal efficiencies were lower than those reported in pilot scale plants with simulated fission product mixtures. No measurement of radioactivity made in the investigation to date has exceeded the emergency levels, i.e., 5,000 $\mu\mu$c./ml. at Cambridge, Mass., set for radioactivity in water containing bomb fission debris. It is hoped that the data and technics presented in the paper will provide a basis for a further evaluation of the ability of conventional water treatment plants to remove fallout radioactivity, and will encourage municipalities and state health departments to make similar investigations. Much of the same equipment and many of the technic should be applicable to measurements of radioactivity whether caused by fallout, reactor wastes, accidental spills into surface water supplies or contamination due to sabotage.

142. Blacklock, J.W.S., Kennaway, E.L., Lewis, G.M. and Urquhart, M.E.: The carbon content of human lungs and bronchial glands. Brit. J. Cancer 8:40-55, 1954.

Estimations of the amount of C were made on the lungs and bronchial glands of 26 males (16 with bronchial carcinoma) and 16 females (5 with bronchial carcinoma) from hospitals in London and on the lungs of 4 males and 4 females who had always lived in Iceland and who had never had bronchial carcinoma. The anatomical, chemical and histological technics are described. In the control material from hospitals in London the average total amount of C in the lungs and bronchial glands was found to be higher in men than in women, 0.90 g.vs. 0.43 g.; the average amount of C in the lungs of females with bronchial carcinoma was greater than that in the controls, 0.63 g. vs. 0.43 g.,but in men it was less, 0.75 g. vs. 0.90 g. The C in the glands was approximately the same for the 2 groups, about 10% of the total. The reason for this difference between the sexes was not apparent. There is a relationship between the number of years lived in towns and the C content of the lungs. In material from Iceland, the content of C in the women's lungs was higher than that in the men's. Compared with the values obtained in London, the lungs of Icelandic men had a lower average C content, 0.60 g. to 0.90 g., while those of Icelandic women had a much higher content, 0.90 g. to 0.43 g. This may be due to spending their days in ill-ventilated farm kitchens, where the fuel consists of peat and dried sheep's dung, but in spite of this cancer of the lung is practically unknown among them. There appeared to be no relation between the number of cigarettes smoked in a lifetime and the amount of C in lungs and bronchial glands; though the figures showed a higher consumption among both men and women with bronchial carcinoma compared with the controls, the material was not statistically adequate. In general there was a fairly close agreement

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Blacklock, J.W.S., et al. (continued)
between histological and chemical estimations of the amount of C present in the lungs. If the C in the lungs and bronchial glands does not leave the body by any channel the amount found post mortem represents what is retained out of the intake of a lifetime. The data now available for atmospheric pollution in some English towns allow an estimate to be made of the amount of C inspired during a lifetime spent in these towns; this may be of the order of 100 g., while the quantity found in the lungs and bronchial glands was 0.5 - 1.0 g., a measure of the efficiency of the nasal and tracheobronchial mucous membrane in arresting and expelling particles. Particles <5μ in diameter are stopped in the nose, smaller ones penetrate and are arrested in the respiratory passages in varying degrees according to size. The average diameter of smoke particles so far observed in the electron microscope has been ca. 0.1μ, and 1/2 of them measure less than 0.075μ, while ca. 1/2 the weight of smoke is made up of particles of more than 0.5μ in diameter. It is estimated that the amount of As and 3:4-benzpyrene contained in the 511,000 $m.^3$ air breathed in a lifetime of 70 years would be 36 mg. and 16 mg., respectively. This amount would be contained in 720 cigarettes of the brands most commonly smoked in Britain, which contain ca. 50 μg. As_2O_3/cigarette.

143. Bushtueva, K.A.: (Correlation of concentration of sulfur dioxide and sulfuric acid aerosol in the atmosphere in dependence on meteorological conditions.) Gigiena i Sanit. 1954, No. 11:11-3.

A brief review of publications on air pollution problems, with special reference to the principal known smog catastrophes, is followed by a report on the author's own investigations. Under various weather conditions, 198 air samples from the Moscow atmosphere were taken during a 24-hour period at one location, and 50 others were collected at various locations of the city. Analyses were carried out in gas absorption bottles equipped with porous glass filters: for H_2SO_4 aerosol determination with 4 ml. redistilled H_2O, and for SO_2 by absorption with PbO_2 and subsequent determination with a 4% $KClO_3$ solution. The results indicate a definite relationship between the 2 gases. 1) The increase in SO_2 concentration of the air is accompanied by increase of H_2SO_4 aerosol concentration, since both of them are produced by burning of fuel in steam boilers, power plants, for heating purposes, etc. 2) This correlation is influenced by the following weather conditions: a) humidity, b) wind velocity and c) cloud formation.

a) An increase in humidity of the air brings about an increase of H_2SO_4 aerosol concentration (both absolute and in relation to SO_2), whereas rain causes a decrease in concentration of this hygroscopic gas. b) Quiet weather enhances the correlation between the gases and also increases the H_2SO_4 aerosol to a concentration 4.5 X greater than that in weather with wind velocities of $\geqq$ 5 m./sec. This explains the frequent and dangerous accumulations of the gas over cities. c) The influence of cloud formation on the correlation of the gases may be summarized in the following rable (correlation given in % in various weathers):

weather condition	correlation SO_2- H_2SO_4 aerosol concentrations
clear	3.27
changing clouds	5.10
overcast sky	6.80
fog	15.70
hours continued fog/day (24 hrs.)	
11/24	30.00
7/24	20.00-24.50
<7/24	10.00-18.00
average for foggy days	32.00

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Bushtueva, K.A. (continued)
In the conclusion, it is stated that the toxic effects of several reported smogs may be attributed to the highly toxic H_2SO_4 aerosol formed from oxidation of air-borne SO_2 or to a combined action of both gases.

144. Cholak, J., Schafer, L.J. and Yeager, D.: Air pollution near an iron slag processing plant. Am. Ind. Hyg. Assoc. Quart. 15:220-6, 1954.
A survey of dust fall from an iron slag processing plant was made following persistence of complaints from residents in the area in spite of efforts to reduce the emissions. The plant was located about 1 mi. from the blast furnace, 0.4 mi. S from a village with population of 500, and 0.5 mi. E from a larger village (population 1200). The principal complainant lived 0.4 mi. N of plant, adjoining its premises. Samples were collected in Pyrex glass jars placed on platforms 10' above ground level at 8 sites, 0.4 mi. from plant, on the main points of the compass, with 4 other sites at various distances from the plant. At the end of each 3-week period the total quantities of materials caught in the jars were determined gravimetrically, dust fall was calculated and the residues subjected to X-ray examination and quantitative spectrographic analysis for trace metals. Samples were collected by electrostatic precipitation once each wk. at 4 stations. Calculation of dust fall at the various locations showed 8.0-28.6 tons/sq.mi./mo. at 0.4 mi., with highest values SW and NW, and 8.7-17.7 tons/sq.mi./mo. at 0.8-1 mi. from plant in Dec. when the plant was shut down; with plant operating, averages for Apr., June and Nov. collections ranged from 21.3-205.2 tons/sq. mi./mo. at 0.4 mi. with the highest value SW, and 30.7-50.8 tons/sq.mi./ mo. at 0.8-1 mi. from the plant. By means of X-ray diffraction studies and analysis of a characteristic constituent of blast furnace slag, an approximate estimation of the contribution of the plant to the total pollution in the area could be made. Large quantities of akermanite ($3CaO.MgO.2SiO_2$) were found in slag and dust collected. Further confirmation was obtained by X-ray studies showing the presence of MnO in both slag and dust. 0.05% MnO had been found in settled dust in the Cincinnati area; averages up to 0.33% were found in the dust fall samples with plant operating, 0.13% with plant shut down. Tons of dust fall /sq.mi./ mo. due to blast furnace slag and particulate matter in the atmosphere are also tabulated. All evidence indicated that the contribution of the plant to the pollution of the area was considerable (30% of the air dirt fall being due to blast furnace slag when plant was operating vs. 8.5% when it was shut down), although the total pollution was not excessive as compared to that of other industrial cities. Further, extensive sand and gravel pits in the area reflected the higher free crystalline SiO_2 content of the collected dust, as compared with Cincinnati samples. Wind rose patterns indicated clearly that winds from S to SW directly affected the area from which complaints came, i.e., downwind from plant about 50% of the time.

145. Clayton, G.D., Giever, P.M. and Baynton, H.W.: Report of Results of Sampling the Atmosphere in the Detroit River Area During 1952. International Joint Commission, Technical Advisory Board on Air Pollution, U.S. Section, 1954, 156 pp.
This report presents the environmental and meteorological findings obtained in 1952 and correlation of these data with those obtained in 1951. During the period extending from Aug.7-Sept.19, 1952, 242 24-hr. samples were collected for total particulate matter (PM) by high volume air samplers at 9 sampling stations strategically located in Detroit.

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Clayton, G.D., et al. (continued)
2,500 spectrographic analyses were made for specific elements in the PM. During the whole of 1952, 18,500 half-hour SO_2 readings were obtained using 2 Thomas Autometers rotated throughout the city. Analyses were made on 4,675 spot samples of the soiling effects of air pollution obtained with the Owens Automatic Air Filter. Light transmission was continuously recorded during 1952. The data for the period Aug. 7-Sept. 19, 1952 were tabulated by half-hour intervals. The median weights for total PM ranged from 170.8 at Station 24 (residential) to 401.7 µg./m.3 air at Station 15 (industrial). By arranging sampling stations according to decreasing median weights, most sampling stations occupied similar positions in 1951 and 1952. Highest median weights were found at sampling stations in relatively close proximity to industrialized areas, while lower median weights were obtained in residential areas quite far removed from industry. For the 9 stations, the difference between the highest and lowest median values was 230.9 µg./m.^{3} air, whereas, the range between minimum and maximum values, by station, was as much as 620 µg./m.^{3} air. The concentration fluctuation was greater at any individual station than between the stations. In general, there was no significant change from 1951 to 1952 in weights of air-borne PM. In 1952, 80.1% of the samples were within the range of 0.0-400.0 µg./m.^{3} air, whereas, 81.7% were in that classification in 1951. In 1952, 19.4% were from 400.1-65.0 µg./m.^{3} air, and 16.1% were in that range in 1951. The data revealed that, in general, major high and low values of total particulates occurred on the same dates at all stations. The daily averages of all 9 stations for 1951 and 1952 were remarkably similar. Total PM of the high volume air samples, after being weighed, was analyzed spectrographically to identify 22 elements qualitatively and semiquantitatively. Al, Fe and Si were the most predominant, having median values of 3.6, 2.4 and 1.7 µg./m.^{3} air, respectively. The median values for V, W, Ni, Bi, Cr, Ba, Mo, Ti, Sn, Cu, Mn, Zn, Pb and Mg ranged from 0.008-0.9 µg./m.^{3} air. Sb, Cd, Co and Be were generally either absent or in trace quantities. Like the median total weight values, the median values for the elements remained quite constant for the 2 yrs. When studying the relationship of the elements in the soil to those in air-borne PM, it was found that with few exceptions, the air-borne PM contained higher concentrations of the elements analyzed than did soil samples. In both air-borne PM and soil samples, Ca, Al, Fe and Si composed approximately 90% of the weight of the 22 elements. When comparing the total weight of PM of the samples collected on Sundays and Wednesdays, there were appreciably heavier concentrations on Wednesdays. There was, however, little difference in the average total weight of the 22 elements between the 2 days. A study of the ratio of the weight of the elements analyzed to the total weight of the sample (PM) on days of light and heavy pollution showed that regardless of the variation in weight of sample, the quantities of the elements present were relatively constant. It is, therefore, apparent that constituents, other than those analyzed, are present in greater quantities when the pollution is high than when the pollution is low; in all probability, these include a substantial amount of organic constituents. During a period of higher than normal total air pollution which resulted in distressing effects upon the community, none of the individual inorganic elements determined increased sufficiently to be considered a pertinent factor. Accurate visibility measurements made with the Transmissometer indicated that a relationship existed between transmissivity and pollutants. The average of readings obtained for the period Aug. 7-Sept. 19, 1952 was 6.5 mi. During a 3-day temperature inversion higher than normal air pollutants were found, and the light transmission was reduced to an average of 2.3 miles. For the period studied, the light transmission average value for Monday was the greatest, 9.4 mi., with Thursday's average value, 3.8 mi., being the lowest. Owens

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Clayton, G.D., et al. (continued)
Automatic Air Filter data showed similar trends at the 2 locations samples. In a residential area, the darkest shading occurred at 5:00 a.m. followed by a rather rapid decrease in color density obtaining a low at 12:00 noon. Samples obtained in the downtown area followed the same general pattern with minimum and maximum density of shade occuring 2 hours later. These data indicate that there was a probable rhythmic pattern associated with the rise and fall of particulates regardless of sampling location in the Detroit area. Frequency distribution of the Thomas Autometer SO_2 half-hour average readings during 1952 were in remarkably close agreement in all concentration ranges with the data obtained in 1951. The average SO_2 concentration for the year was 0.06 ppm. Each day of the week also showed the same average value. Monthly average SO2 concentrations were as follows: Jan.-0.10, Feb.-0.08, Mar.-0.08, Apr.-0.06, May-0.05, June-0.02, July-0.02, Aug.-0.03, Sept.-0.04, Nov.-0.07 and Dec.-0.11 (instrument out of order in Oct.). The greatest % of peak values of SO_2 occurred between the hours of 12:00 midnight and 3:59 a.m., while the lowest % occurred between 4:00 and 7:59 p.m. During 1952, the highest momentary SO_2 concentration was 2.40 ppm which occurred in July. The SO_2 concentration at Station 11 was much higher during the sampling period of Jan. 11-31 than for the period July 25-Aug. 31, probably indicating that the concentration of SO_2 was more closely related to the time of the year than to sampling locations. A meteorological study of 1952 revealed that, in general, it was typical of the climatology of the area. Daily surface weather reports at Detroit City Airport and 4 radio soundings at Selfridge Field Air Force Base were used as indicators of stability from Aug. 7-Sept. 19, 1952. PM samples collected in Detroit and Windsor were combined and averaged to establish, for meteorological comparisons, a daily pollution level. High pollution periods were concurrent with light winds. Rapid cleaning of the air was associated with increasing wind speed. High pollution was associated with high stability and above normal temperatures; low pollution was associated with high instability and cooler temperatures. The mean total particulate concentration for Detroit-Windsor on a day the predominant wind direction was NE was 100 $\mu g./m.^3$ air, NW 180, SE 296 and SW 271. The lower concentrations obtained when the wind was from the northerly direction was explained partly by the greater instability and a predominance of lower than normal temperatures associated with the NE and NW winds and that just the reverse conditions are concurrent with the SE and SW winds. Cold frontal passages, in general, caused a reduction in pollution concentration. The effects of rainfall on pollution concentration was indeterminate.

146. Committee on Air Pollution (Beaver, Sir H., Chairman): Report, Presented to Parliament by the Minister of Housing and Local Government, the Secretary of State for Scotland and the Minister of Fuel and Power by Command of Her Majesty. London, H.M. Stationery Office, 1954, 80 pp.

The committee on air pollution, with Sir Hugh Beaver as Chairman, was appointed on July 21, 1953 "to examine the nature, causes and effects of air pollution and the efficacy of present preventive measures; to consider what further preventive measures are practicable and to make recommendations." This is the report of their findings.

The chronic ill effects of air pollution on health are illustrated by comparing the death rates from bronchitis in the Scandinavian countries with England and Wales in 1951; for males, the death rate/100,000 was 2.2-5.0 in Denmark, Norway and Sweden vs. 107.9 in England and Wales,

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Committee on Air Pollution (Beaver, Sir H., Chairman). (continued)
and for females it was 1.9-4.0 vs. 62.7. The death rates from pneumonia, bronchitis and other respiratory diseases (except influenza) in 1952 in England and Wales, by centers of population, show a consistent decrease from 120.65 in urban areas of 100,000 and over to 78.15 in rural areas. The death rate in Scotland followed the same pattern. For deaths from all causes due to respiratory diseases (except influenza), males show a consistently higher death rate than females: 12.12 vs. 8.19 in urban areas of 100,000 and over - 8.98 vs. 6.44 in rural areas. It is suggested that these comparative death rates for urban and rural areas generally indicated that atmospheric pollution may be a factor in the production of cancer of the lung. Air pollution is also considered harmful because it obscures natural light and thus reduces resistance to infection and retards recovery from illness. The psychological effects of reduced light and sunshine may be no less serious than the physical effects.

The economic cost of air pollution is estimated at £ 250 million/yr. in terms only of losses that can be given a monetary value; this does not include the value of the fuel that is lost through incomplete combustion nor the loss of happiness and health. Industrial smoke, grit and dust, pollution from special processes, S pollution, railway smoke, motor vehicle exhausts and domestic smoke are discussed with respect to what preventive measures are in force at present, and, in particular, what further preventive measures are needed.

Recommendations entailing legislation include the prohibition of the emission of industrial smoke, grit and dust with exceptions for certain conditions and processes; the control of smoke from railways and pollution from colliery spoilbanks; provision for smokeless zones in which the emission of smoke from chimneys would be entirely prohibited and for smoke control areas in which the use of bituminous coal for domestic purposes would be restricted and for conversion to more efficient fuel-burning appliances in such areas with governmental financial assistance. Responsibility for enforcing these laws should rest with local authorities, except for those concerning "special process" industries. Penalties for smoke offenses should be increased. Other recommendations include issue of codes of practice in smoke reduction and standard specifications for smoke indicators, and issue of simpler standard methods of sampling flue gases by the British Standards Institution; recognition of the skill of good stoker firing; adoption of a governmental loan scheme and tax reduction for industries which are installing equipment that reduces air pollution; the extension and acceleration of electrification of railways and of conversion to diesel locomotives; the enforcement of control of pollution from motor vehicles; the adoption of a national clean air policy; the promotion of technical development and research work and promotion of cooperation and efficiency among local authorities in enforcing such legislation. The Appendices I-XII include Recommendations for Immediate Action, Economic Cost of Air Pollution, Research and Development, Performance of Grit and Dust Arresting Plant, Measurement of Smoke, Influence of Chimney Design and Height on Gas Dispersion, Measurement of Air Pollution, Characteristics of Coal for Steam Raising, Domestic Appliances, Estimated Costs of Continuous Room Heating, Provision of Smokeless Fuels and Measures in Other Countries For the Abatement of Pollution.

147. Cooper, R.L.: The determination of polycyclic hydrocarbons in town air. Analyst 79:573-9, 1954.

A method for detecting and determining polyclyclic aromatic hydrocarbons in town air is described with respect to sampling extraction, analysis and determination. The basic technic is a combination of chromatography on alumina and absorption spectrophotometry. In particular, the determination of 3:4-benzpyrene in the presence of other similar hydrocarbons is discussed; the method for determining the former in the presence of 1:12-benzperylene,

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Cooper, R.L. (continued)
the most interfering of the hydrocarbons, is outlined. The results of an examination of the Salford atmosphere for pyrene, 3:4-benzpyrene, 1:12-benzperylene, anthracene and fluoranthene from Nov. '52 - Mar. '53 are given in both ppm hydrocarbon in smoke and µg./100 m.^{3} air. The concentrations of pyrene ranged from 305-470 ppm in smoke and 18.0-35.0 µg./100 m.^{3} air; 3:4-benzpyrene ranged from 290-425 ppm in smoke and 19.7-29.0 µg./100 m.^{3} air; 1:12-benzperylene, 235-460 ppm in smoke and 16.1-35.0 µg.; anthracene, only measured in Jan. and Feb., 30 and 15 ppm and 2.0 and 0.75 µg., respectively; and fluoranthene, only measured in Feb., was 400 ppm and 20.0 µg. In general, the low values occurred in either Dec. or Mar. and the high values in Jan. or Feb. The relation of the results to cancer of the lungs is discussed. The average man inspires 20 m.^{3} air/day and this, in a town such as Salford, can contain as much as 4-5 µg. of 3:4-benzpyrene, which shows marked carcinogenic properties. It is thought that atmospheric pollution by smoke is not the sole cause of the recent increase in cancer of the lung, but that cigarette smoke inhaled into the respiratory tract contains powerful solvents, such as pyridine, to dissolve the inactive carcinogens adsorbed on the soot and thus render them active. Or possibly, the smoke may contain other substances that promote carcinogenic action.

148. Curwen, M.P., Kennaway, E.L. and Kennaway, N.M.: The incidence of cancer of the lung and larynx in urban and rural districts. Brit. J. Cancer 8:181-98, 1954.

The mortality due to cancer of the larynx has shown little change in the last 20 years, whereas that due to cancer of the lung has increased. The mortality due to cancer of the lung and larynx in the County Boroughs, Urban Districts and Rural Districts of different parts of England and Wales is analyzed for the period 1946-49. The standard mortality ratio (S.M.R.) for cancer of the lung in both sexes and of the larynx in males increases with increasing urbanization (rural districts< urban districts<county boroughs). Cancer of the female larynx shows exactly the reverse relationship. These trends apply equally when the figures are analyzed according to the separate regions, but there are differences between regions, which may or may not be due to differences in degree of urbanization undetected by the classification used. In particular, the S.M.R.'s for Wales are very low for the lung and male larynx, but very high for the female larynx. The urbanization gradient is less steep for the female lung than for the male lung. The mortality due to cancer of the male lung is positively correlated with the numbers of persons/acre in the Rural Districts of the 11 regions of England and Wales. The significance of these findings is discussed in the light of the possible etiology of cancer of the lung and larynx, but no definite conclusions were reached. The anatomical and sexual distribution of 964 cases of cancer of the larynx is tabulated. Cancers of the larynx in men and women are to a large extent different diseases, the so-called extrinsic group being more frequent in women. The literature on the relation of the Paterson-Kelly syndrome to cancer, and on possible dietetic and social factors in this condition, is summarized.

149. Daly, C.: Air pollution and bronchitis. Brit. Med. J. 2:687-8, 1954.

An analysis by the Social Medicine Research Unit of the Medical Research Council of the relationship of SO_2 content of total solid matter to bronchitis similar to that of Pemberton and Goldberg (Brit. Med. J. 2:567-73, 1954) gave results that were in good agreement. However, PbO_2 instruments for measurement of SO_2 pollution were in use in only 15 county boroughs and $SO_4^=$, as a dissolved impurity in deposit gauges, was measured

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Daly, C. (continued)
in only 24 county boroughs. The correlation coefficients obtained for males aged 45-64 for the years 1946-50 were r=0.51, using the 1st index of pollution, and r=0.32, using the 2nd. Because of the small number of stations and the considerable variation of results among closely located stations, a new measure of atmospheric pollution was chosen, the consumption of domestic coal/acre; this extended the study to all 83 boroughs in England and Wales. Though only preliminary investigations have been made, the coefficient of correlation between the average annual mortality from bronchitis in males 45-64 yrs. for 1950-2 and the consumption of domestic coal/acre in 1952 is 0.59; this is highly significant. Taking into account other variables, viz., social class and overcrowding, only reduced the coefficient to 0.52 and 0.53, respectively. When the consumption of all coal (except for railways and shipping) is correlated, the coefficient is only 0.24. Since SO_2 evolution from nondomestic coal/ton is about the same as for domestic coal, but smoke evolution is lower, it would seem premature to attribute the bad effects of air pollution primarily to SO_2. The correlation coefficient between domestic coal consumption and the death rate from "bronchitis and pneumonia" of females 45-64 yrs. for 1950-2 is 0.54.

150. Ely, S.B., Supt.: 1954 Report of the Bureau of Smoke Prevention, Pittsburgh, Pa., Department of Public Health, 1954, 20 pp.
A digest of the Pittsburgh Smoke Ordinance No. 344 is given. A comparison of the hours of moderate and of heavy smoke for each year from 1946-54 as observed by the U.S. Weather Bureau shows a reduction of heavy smoke in 1954 over 1946 of 98.7% and a reduction of total smoke of 85.8%. Dustfall collected in 12 cans throughout the city gave an average of 47.6 tons/sq.mi./mo. Spectrographic analysis of the can deposits showed 20.43% Fe_2O_3, 9.17% Al_2O_3, 20.38% SiO_2, 1.85% MnO, 1.67% MgO, 4.79% CaO, 0.06% ZnO, 0.09% Cr_2O_3 and 0.07% SO_3. The inspectors' report and the Pittsburgh railroads report are also included.

151. Faith, W.L.: Combustion and Smog. Report No. 2. The Relation of Combustion Processes to Los Angeles Smog. Los Angeles, Air Pollution Foundation, 1954, 63 pp.
The table of contents include the following sections: The contribution of combustion processes to Los Angeles smog; Combustion of natural gas and fuel oil; Role of auto exhaust in smog formation; Diesel trucks and buses; Incineration of refuse and Miscellaneous combustion processes. In the section on the role of auto exhaust in smog formation, the experiments on eye irritation by Haagen-Smit, the Air Pollution Control District of Los Angeles and the Stanford Research Institute are discussed. The material of this chapter is contained in the following abstracts:
Cadle, R.D. and Magill, P.L.: Study of eye irritation caused by Los Angeles smog. Arch. Ind. Hyg. and Occupational Med. 4:74-84, 1951.
Haagen-Smit, A.J.: Chemistry and physiology of Los Angeles smog. Ind. Eng. Chem. 44:1342-6, 1952.
Los Angeles County Air Pollution Control District: Second Technical and Administrative Report on Air Pollution Control in Los Angeles County, 1950-51, Los Angeles, 1951, 51 pp.
Magill, P.L. and Benoliel, R.W.: Air pollution in Los Angeles County. Contribution of combustion products. Ind. Eng. Chem. 44:1347-51, 1952.
Stanford Research Institute: The Smog Problem in Los Angeles County; A report on the nature and causes of smog. Los Angeles, Calif., Western Oil & Gas Assoc., 1954, 134 pp.

152. Flint, F.J.: Cor pulmonale. Incidence and etiology in an industrial city. Lancet II:51-8, 1954.
This survey includes all patients with heart failure admitted to the City

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Flint, F.J. (continued)
General Hospital, Sheffield, between Mar. 17, 1952 and Mar. 16, 1953. Cor pulmonale was the commonest form of heart failure among the males. In 159 males, most of whom were 50-70 yrs. old, there were 64 cases of cor pulmonale, 33 of ischemic heart disease, 26 of rheumatic heart disease, 26 of hypertensive heart disease and 10 other cases. In 141 females, there were only 12 cases of cor pulmonale. The clinical features and the electrocardiographic and radiological pattern of cor pulmonale are described. Thrombo-embolic complications were rare, occurring only once in 76 patients. Of the 64 male patients with cor pulmonale, 42 had chronic bronchitis and 16 bronchiectasis. None of the 12 females had uncomplicated bronchitis. Most, if not all, of these patients had emphysema. The precipitating cause of heart failure in 74 of the 76 cases of cor pulmonale was an acute respiratory infection, usually acute bronchitis; most of the patients were admitted during the winter. Most of them with cor pulmonale came from crowded homes, and all but 2 had a chronic infection of the respiratory tract with acute exacerbation; 66% had been engaged in the heavy Fe and steel industry, and most of them had been exposed to excessive inhalation of various dusts, including SiO_2, or to rapid changes of temperature; all had been exposed to the polluted atmosphere of Sheffield, and the incidence of heavy cigarette smoking was higher in this group than in the controls. Each of these factors may damage the respiratory tract. A third of the patients died, and for these 26 persons, the average length of time between the first attack of congestive heart failure and death was 18 months, the maximum being 5 years. An incidence of 25% for cor pulmonale in all patients (40% in men and 8.5% in women) far exceeded the 5% incidence reported by Wood. The mechanism of heart failure in cor pulmonale and the etiology of chronic bronchitis are discussed. The author stresses the importance of combatting air pollution.

153. Fry, J.: Chronic bronchitis in general practice. Brit. Med. J. 1:190-4, 1954.

It is believed that chronic bronchitis is in some degree responsible for 30,000 deaths and for 16.5 million lost days from work annually (based on Report of Ministry of National Insurance, 1950). 15% of all medical retirements are reported (Treasury Deputy Medical Adviser's Rept., GPO, 1951.) due to this cause. Around 10% of all attendances in general practice are for chronic bronchitis. It is an indefinite clinical entity, which probably includes a number of separate and distinct clinical conditions. In a study of a single S.E. London practice, 127 chronic bronchitics were diagnosed (incidence of 28/1000) during one year. Males numbered 71 and females 56. The incidence rose with age. No social predisposition was noted. It was a chronic condition. In more than half the cases it had already been present for >10 years. The commonest age of onset was between 30 and 60. In this particular series there was no difference between the smoking habits of those with chronic bronchitis and controls. A third of the patients were incapacitated from their usual occupation for >1 month during the year. An attempt was made to grade the disease into 4 groups of severity. At present, only palliative measures can be taken in the management of cases. Until its causes are defined and rational steps taken to prevent the condition, little progress can be made. The most helpful lines of research may be closer studies of the natural course and distribution of the disease. The mortality rate from chronic bronchitis in England Wales is by far the highest in the world. It is some 30 times that in the U.S.A. There is no doubt that atmospheric pollution as fog produces serious effects in the chronic bronchitic and in other ill people, for 4,500 deaths in Dec. 1952 were directly attributed to fog.

154. Gruber, C.W.: Odor pollution from the official's viewpoint. In: American Society for Testing Materials: Symposium on Odor. Presented at the 57th Annual Meeting, Chicago, Ill., June 15, 1954, ASTM Spec. Tech. Pub. No. 164, 1954, pp. 56-65.

Establishing odor pollution claims is difficult for the nature of the odor can change from the time the complaint is received until it can be acted upon. The section of the Cincinnati Ordinance on odor is quoted. A total of 231 chemical product classifications are represented in the Cincinnati area. These include: industrial inorganic and organic chemicals, drugs, medicines, soap and glycerin, cleaning and polishing preparations, sulfonated oils, paints, varnishes, lacquers, japans, enamels, inorganic color pigments, whiting, wood fillers, fertilizers and vegetables and animal oils and fats. 8 cases of odor nuisances and their solutions are presented; these included a brewer's grain-drying plant, an adhesive manufacturing plant, animal hide cooperative, partially incinerated animal remains, an asphalt still, a coffee-roasting plant, a varnish-cooking plant and a chemical plant producing printing inks, lacquers, dye stuffs and pharmaceuticals. The last case was the most chronic and difficult to deal with and is reported in more detail. Several neighborhood surveys were made from 1950-53 to assess the progress of odor control in this plant and gradually the odor emissions were reduced to a minimum. From these case histories it was concluded that a system of odor measurements is sorely needed, particularly one that will assign a number to represent an odor intensity, i.e., something similar to the Ringlemann chart for smoke. The device need only indicate the recognition threshold, not the absolute odor threshold. Also, an odor chart with which the untrained observer can uniformly describe odor quality is needed. Such a chart was prepared and 57 observation runs over a 23-mi. odor route were made in the summer of 1953 from 6:00 p.m.-midnight, 5 nights/wk. (meteorology of area intensifies odor pollution at this time). This experience indicated that the odor chart needs simplification and clarification to make it more useful. It is concluded that the usual complaints of odor pollution involve very small concentrations of pollutants of a complex nature so that evaluation by the usual methods of sampling and chemical analyses is difficult and time consuming. Thus, the "sniff" method by trained observers looms as the practical means of determining and describing the odor level.

155. Hallgren, W., Karlsson, N. and Wramby, G.: Molybdenförgitning ("molybdenos") hos nötkreatur i Sverige. (Molybdenum poisoning ("molybdenosis") in cattle in Sweden. Nord. Vet. Med. 6:469-80, 1954.

In the Western part of Sweden, the authors observed Mo poisoning in dairy cattle grazing a pasture contaminated with smoke from a steel plant about 100 m. away. The smoke contained Mo. One cow died, and autopsy revealed hyperemia of the jejunal mucosa, fatty degeneration of the liver, as well as a Mo content of 0.7 mg./l. in the blood serum. The other affected cows recovered on being removed from the pasture. 2 horses grazing the same pasture were not affected, although the Mo contents of their blood serum was found to be 1.1 and 1.4 mg./l., respectively, which is considered very high. It is stated that the Mo contents of the blood in the affected cattle were 25 times that of normal cattle grazing another pasture.

Analysis of the vegetation on the contaminated pasture revealed a Mo content of up to 231 mg./kg. of dry matter, as compared with the normal Mo content which is ca. 1.5 mg./kg. of dry weight.

156. Hoffmann-Axthelm, W.: Weitere Beobachtungen über den Einfluss chronisch zugeführten Fluors auf den Organismus. (Additional observations on the effect of chronic fluoride poisoning.) Deut. zahnärztl. Z. 9:558-65, 1954.

The observations reported in 1953 in respect to the endemic F region

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Hoffmann-Axthelm, W. (continued)

Berggiesshübel, Saxony, have been extended to the examination of the skeletal system of a number of the inhabitants. A total of 15 persons of both sexes, including 2 children most affected by mottled enamel, aged 9 and 12, and the others ranging from 31-69 years were examined roentgenologically. In no cases were changes seen that could not be explained on the basis of age and developmental stage. The X-rays of a case of osteosclerosis of a 50-year old worker in the "Fluorwerk Dohna" were referred to the author by a physician (Dr. Fritz) of Dresden-Johannstadt for comparison. Cattle born in the vicinity of this plant showed osteomalacia. Dental changes seen in cattle are described and illustrated; the same manifestations were found in sheep born in this latter region. The ill effects of F described by Spira are countered by the author's own observations; 269 school children from Berggiesshübel (including those affected by mottled enamel) were asked the questions posed by Spira to children in his survey. The results showed nothing in common with Spira's values. In addition, children were questioned as to whether they were hard of hearing; nothing attributable to F could be established. The physicians at Fluorwerk Dohna were questioned as to incidence of parasthesia, dermatoses and alopecia, constipation, among workers exposed to F. No incidence greater than that observed in the general population was reported, except for furunculosis (in those exposed directly to F), particularly no changes in the fingernails. No cases of otosclerosis have been observed among F workers by the present medical director. A differential blood count of 117 persons (85 children, 12 men, 20 women) showed noteworthy variation only in eosinophils which, however, was attributable entirely to oxyuriasis. (Conclusions are that prevention of dental caries by F within recommended limits is safe.)

157. Huber, T.E., Joseph, S.W., Knoblock, E., Redfearn, P.L. and Karakawa, J.A.: New environmental respiratory disease (Yokohama asthma). Arch. Ind. Hyg. and Occupational Med. 10:399-408, 1954.

A type of asthma (Yokohama asthma) different from that occurring in the U.S. was first noted among the U.S. Army personnel in Yokohama in autumn, 1946. This disease was also found to occur among the indigenous Japanese, and in other parts of Japan that were in proximity to a harbor, usually surrounded by low hills, had sundry manufacturing facilities and the occurrence of "heavy smog" during the winter months. The clinical course of the disease is outlined. Biological studies in which pollen slides were collected monthly throughout Yokohama and intradermal testing with extracts of typical pollinating plants proved negative. Meteorological and pollution studies gave more positive results. Wind velocity, precipitation and inversions were found to bear a statistical relationship to the incidence of the respiratory disease entity. When the atmosphere was sampled for SO_2, N oxides, O_3, amount of dust and presence and amount of ether-soluble aerosols, a correlation between incidence of disease and air contaminants and smog formation was found and a significant correlation of the ether-soluble aerosols and dust with the incidence of the respiratory disease entity. This is demonstrated in the following table.

Contaminant	Smog-Free Days	Days of Smog Formation
Ether-soluble	0.011 mg./m.^{3}	0.081 mg./m.^{3}
Dust index	1.0	3.8
Sulfur dioxide	0.075 γ/l.	0.17 γ/l.
Ozone	0.081 γ/l.	0.17 γ/l.
Nitrogen oxides	0.26 γ/l.	0.50 γ/l.

158. Kreyberg, L.: The geographical distribution of histological subgroups of primary epithelial lung tumours in Norway. Brit. J. Cancer 8:599-604, 1954.

This report covers 235 cases of primary epithelial lung cancer, recorded in Norway during the period 1952 through 1954. The patients (202 males, 33 females) had been hospitalized in various parts of the country. They were distinguished as belonging to either of 2 cancer groups: group I (172 males, 4 females) included carcinomata of the squamatous cell, large cell or small cell type, while group II (30 males, 29 females) was composed of bronchiolar cell cancer, adenomata, adenocarcinomata and salivary cell tumors. Further, the distribution was classified with regard to the patients' origin in a community of 1 of the following types: a) countryside, b) rural or nonindustrial towns, c) smaller industrial towns and centers (Sauda, Odda, Årdal) and d) larger towns (Oslo, Bergen, Trondheim). The tabulated data indicate that, in contrast to group II cancer, characterized by incidence distributed evenly over the whole country, carcinomata of group I type occurred predominantly in highly industrial areas, the incidence being lowest in counties principally engaged in agriculture, forestry and fishery. The following conclusions are drawn from the above: the rural areas still show the same distribution of cancer incidence and the same sex ratio that was observed for the entire country and also for Oslo a few decades ago. Apparently, the incidence of lung cancer is linked with all types of urban settlements, with Oslo leading in that respect. Small industrial towns have no lower incidence than have other small towns. The cancer incidence in Norway is attributed to the urban mode of life rather than to exposure to the inhalation of smoke and fumes.

159. Kreyberg, L.: Occupational influences in a Norwegian material of 235 cases of primary epithelial lung tumours. Brit. J. Cancer 8:605-12, 1954.

A detailed analysis of 235 cases of primary epithelial lung tumors from 202 males and 33 females shows that people in "dusty" work are more liable to develop lung tumors than people with "open air" occupations and "house-" work. "Clerical" and "professional" workers likewise developed a higher number of lung tumors as compared to the category "open air" activities and "house"-work. These observations, in addition to the previous findings, that smoke and fumes from industry in general do not seem to influence the lung tumor development, whereas urbanized living does, lead to the tentative conclusion that the new carcinogenic situation for lung cancer development, up to the present time, probably is linked to the males' personal life habits. These conclusions seem valid in the present stage of the lung cancer development in Norway. (Author's summary.)

160. Leroux, J. and Trillat, J.J.: Étude comparative des poussières atmosphériques minerales de quelques grandes villes. (Comparative study of the atmospheric mineral dust over some large cities.) Compt. rend. 238:1748-50, 1954.

Selected samples of dust from the commercial and industrial zones of Windsor and Ottawa, Canada, Paris, Marseille, Rome and Venice were studied by X-ray diffraction. In the sample from each of these far-removed cities, a common diffraction spectrum was observed in which quartz, feldspar, calcite, gypsum, anhydrous $CaSO_4$, hematite and magnetite (partial X-ray photos given) were qualitatively identified. Relatively small quantities of nonmagnetic metallic, round particles and amorphous, vitrified, round particles were also observed microscopically. The relative proportions of each of the 7 minerals varied according to the locality, but the calcite always seemed to predominate. No concentrations are given.

161. List, R.J.: On the transport of atomic debris in the atmosphere. Bull Am. Meteorol. Soc. 35:315-25, 1954.

Collections of radioactive debris were made daily at 120 Weather Bureau stations throughout the U.S. during the atomic test series in Nevada in the Spring of 1952. The debris deposited on a horizontal surface was collected by exposing sheets of gummed paper at 91 stations and air-borne debris was collected at 51 stations within 1000 miles of the tests by high volume air filters. The gummed sheets and filters were reduced to ash and the β-activity measured. These measurements were extrapolated to the sampling date by ascribing the measured activity to a particular burst, which was usually uncertain for several reasons, and assuming that the decay has been proportional to $t^{-1.2}$. It is considered that the results show a higher activity than actually existed. The meteorological factors involved in the transport and deposition of debris are discussed. Precipitation greatly increased the activity of the gummed sheets, but did not affect the air-borne samples. Several examples of the relation of computed meteorological trajectories to actual observations of debris are given.

162. Ministry of Health: Mortality and Morbidity During the London Fog of December 1952, Report by a Committee of Departmental Officers and Expert Advisers appointed by the Minister of Health. Reports on Public Health and Medical Subjects, No. 95, H.M. Stationery Office, 1954, 61 pp.

The main object of this investigation of the medical aspects of the Dec., 1952 London fog was to try to discover the factors responsible for the increased mortality from a statistical investigation of the Registrar General's figures on the fatalities.

The meteorological factors (i.e., anticyclone centered over Southern England, low temperatures and absence of wind, and therefore, temperature inversion) and the distribution of the fog as obtained from recordings at a number of observation points throughout Greater London for Dec. 5-9 are given in detail. Measurement of the atmospheric pollution was collated by the Fuel Research Station of the Department of Scientific and Industrial Research (see Wilkins, E.T.: J. Roy. Sanit. Inst. 74:1-15, 1954.). The daily total suspended matter (smoke) and SO_2 concentrations for Dec. 2-10 at 12 Greater London sites are compared with the mean Dec., 1951 concentration of these 2 pollutants. Highest concentrations of the 2 (4.46 mg./$m.^3$ smoke and 1.34 ppm SO_2) occurred at Lambeth County Hall on Dec. 7-8 as compared with normal concentrations of 0.12-0.44 mg./$m.^3$ smoke and 0.07-0.23 ppm SO_2. Sharp increases in both occurred from the 4th to the 5th. Maps showing comparative SO_2 concentrations throughout the whole area during Dec., 1951 and during Dec. 5-9, 1952 are given.

Information on mortality and morbidity from the General Register Office Statistics estimates that the number of deaths attributable to the fog was between 3,500-4,000, but closer to 4,000. The number of deaths/wk. (Oct. 18-Mar. 28) shows a sudden rise in the wk. ended Dec. 13 followed by a marked fall to a level well above that for the wks. immediately preceding the fog. The number of deaths/day (Nov. 29 - Dec. 16) shows that the peak occurred on Dec. 7-8. Wilkins' opinion that the 2nd peak in mortality during Jan. and Feb. might be due to the aftereffects of the Dec. fog or to a 2nd rise in atmospheric pollution in Jan. and Feb. is discussed; however, all the evidence points to the epidemic of virus influenza in Jan. and Feb. as being the cause of the great mortality at that time. The deaths by area (London A.C., Outer Ring, 160 Great Towns) are tabulated; this shows the greatest increases in deaths in the wk. ended Dec. 13 over the preceding wks. were in the Administrative County of London (200% increase) and the part of Essex lying within Greater London (148%), and the least in the part of Kent within Greater London (79%). No close correspondence between the areas of greatest SO_2 pollution and those of greatest mortality

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increase was found. The extent of the effects of SO_2 pollution was probably influenced by social and occupational factors. Increase in mortality was highest for adults >45 (1,472 deaths) who accounted for 90% of the increase, with those >65 accounting for 60-70% of the increase and deaths in children <1 yr. were approximately doubled. An analysis of deaths by cause shows that 81% of the increase in deaths (1,248 deaths) occurring in the wk. ended Dec. 13 were due to diseases of the respiratory and cardiovascular systems. Respiratory disease alone accounted for ca. 59% of the total increase for the wk. ended Dec. 13 and for >76% for the wk. ended Dec. 20, with chronic bronchitis predominating. In an analysis of the deaths due to bronchitis, it seems that its pattern of mortality is not markedly different from that in an average winter wk., but that the fog hastened the deaths of a number of patients. An examination of the coroners' reports, in which ca. 1/5 of the deaths in London are certified, gave the following limited information. All the deaths, excluding those from murder, suicide and accident, and any other unrelated cases, were caused by disorders either of the cardiovascular or respiratory systems or from a combination of both. Those from respiratory diseases increased to >4 X normal during Dec. 5-8 and remained high for some time; those from cardiovascular diseases increased to ca.3 X normal at this time and dropped abruptly when the fog cleared. Broken down into further causes, bronchitis and emphysema showed the greatest proportionate increase: from 24 - 173 (factor of 7.2) and from 8 - 92 (factor of 11.5), respectively. Coronary and associated lesions increased from 97 - 279 (factor of ca. 2.9); this was in proportion to the increase in the total number of deaths. Little further information could be derived from the coroners' cases. Histological examination of 8 lungs showed slight but strikingly constant superficial inflammation of the mucosa of the larger bronchi. However, these observations were made some months after the fog and they could not be confirmed in lungs from other sources. Virus A influenza was isolated from the lung of 1 person who was taken ill on Dec. 8 and died on Dec. 12. No further isolations were made until the last week in Dec., 1952. An exhaustive chemical examination of lung specimens from 4 coroners' autopsies, including spectrographic tests for trace elements, failed to show any significant difference between the mineral content of the lungs from victims of the fog and that of the control lung. The reports of several metropolitan Medical Officers of Health are given; however, since they did not follow any set form the reports did not admit of statistical tabulation.

Information on morbidity is much more scanty than that on mortality. Sickness claims of the Ministry of Pensions and National Insurance show an increased rate of sickness (28,900 claims instead of the expected 19,900) which is, however, considerably less than the rise in mortality, and the rise did not occur during the week of the fog (Dec. 2-9) but during the following week. The reason, in the 1st instance, probably lies in the fact that the sickness claims relate only to the working population, whereas mortality statistics show that the harmful effects of fog were seen mostly in people >65 and in people who were already suffering from chronic ill health. Statistics of hospital admissions show an increase of 750 - 1,110 patients. Applications, when broken down by category, show an increase in respiratory and cardiac disorders, but no increase in the other 3 categories. Though an increase in pneumonia cases was noted in London Administrative County, it was not exceptional when compared to the number of cases in the remainder of Greater London. Some observations of 4 general practitioners on morbidity among their patients are given.

Previous fog incidents over the past 80 years are reviewed. All of these, with the exception of the fogs of Nov., 1948 and Dec., 1952, were accompanied by extremely low temperatures, 10-15° below freezing. By

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contrast, in both the '48 and '52 fogs, temperatures remained either at or a few degrees above freezing. However, mortality, and in particular that from bronchitis, in 1952 was much greater than in 1948, or in any other previous fog. The mortality from the Meuse Valley and Donora, Pa. fog incidents is also reviewed, and the similarity in the pathology of the conditions produced is pointed out.

From all the evidence, there is nothing to suggest that the Dec., 1952 fog episode produced a new clinical or pathological syndrome. It seems that the contaminated fog exerted its evil effects by exacerbating illness and by precipitating death in those already affected by other conditions, viz., respiratory and cardiovascular, mainly of a chronic nature. There is also evidence that not all cases of chronic respiratory disease were affected to an extent calling for medical attention. The immunity of these cases was attributed to the fact that they remained indoors at rest and for the most part in bed. SO_2, SO_3 and CO are discussed as probable irritants because of the similarity in their effects; however, concentrations during the fog of the latter 2 are not known.

The effects of the fog on cattle at the Smithfield Cattle Show are discussed in Appendix A. Neither the sheep nor the pigs in the show were affected. More detailed tabulated statistics on the distribution of SO_2 in the fog and mortality data are given in the Appendixes B-G.

163. Moore, C.E., McCarthy, R. and Logsdon, R.F.: A partial chemical analysis of atmospheric dirt collected for study of soiling properties. Heating, Piping, Air Conditioning 26, No. 10:145-9, 1954.

A number of atmospheric dirt samples were collected over American cities and analyzed for free C, ash, SiO_2 and mixed oxides (R_2O_3). The results of the analyses indicated a wide variation in the composition of the dirt occurring over the various metropolitan areas. Free C ranged from 55.8% in Indian Orchard, Mass. - 7.7% in Hartford, Conn.; ash - 74.6% Hartford, Conn. - 9.4% Indian Orchard, Mass.; SiO_2 - 42.3% Tulsa Okla. - 5.9% Indian Orchard, Mass. and R_2O_3 - 30.3% Kalamazoo, Mich. - 3.2% Indian Orchard, Mass. The data also show local variations which appear to be related to such factors as terrain and economic level of the neighborhood. Details of the sampling procedure are discussed, a table of the summary of results of dust analysis is given and graphs showing the number of samples containing a particular % range for each component analyzed are constructed. The greatest number of samples contained 35-40% free C, 45-50% ash, 20-25% SiO_2 and 15-20% R_2O_3.

164. Nader, J., Goldin, A.S. and Setter, L.R.: Radioactive fallout in Cincinnati area. J. Am. Water Works Assoc. 46:1096-100, 1954.

Precipitation at Cincinnati from Mar., 1953-Mar., 1954 was sampled and tested for suspended and soluble β-radioactivity. During and immediately following the 1953 spring series of weapons tests (Mar. 19-June 29) the radioactivity in the 10.86" of rainfall varied from 280-319,000 μμc./l., as compared with a prebomb test background activity of 50 μμc./l. Only 3 rains can generally be attributed to particular bomb bursts, on the basis of a comparison of the half-lives of rain activities with the theoretical decay of the fission product. It was estimated that, on June 10 and Dec. 10, 1953, the accumulated rainfall activity/sq. mi. would have decayed to ca. 2.4-0.15 c., respectively. Surface and cistern waters collected after rains having an activity of 50-500 times background showed an activity within 3 times background. (Author's summary.)

165. Poppe, W.H., Jr.: The potential fluorine hazard in the fertilizer industry. Com. Fertilizer 88, No. 1:42, 44-5, 73-4, 1954.

The Wisconsin State Board of Health was requested to investigate the source of irritating gases, escaping into the atmosphere and causing irritation to the eyes, nose and throat of the people living in the neighborhood of a fertilizer manufacturing plant. This led to engineering studies in 3 phosphate rock and 4 fertilizer blending plants. The results showed that a definite F health hazard exists in the commercial fertilizer plants where natural phosphate rock materials are used. Corrective measures have been taken by some of the plants. Since F poisoning is a compensable disease in Wisconsin, the Industrial Commission is interested in its control. At 1 plant visited, the working environment was so intolerable that one could not stand by the sampling equipment while the samples were being collected. A total of 46 environmental air samples and 91 urine specimens were collected during the course of the studies. Air samples were collected in all-glass impingers, scrubbed with either distilled H_2O or 0.1 N. KOH. A standard colorimetric F method was used for the determination in the distillate. Tabulation of results show 20% atmospheric concentrations of H_2F_2 in the acidulating plants (total of 36 samples) to be very excessive (over 9 ppm), 11% excessive (6-9 ppm), 25% high (3-6 ppm), 44% low (below 3 ppm); the corresponding percentages in the blending plants (total of 10 samples) were 40, 20, 20 and 20. The urinary specimens of workers of acidulating plants (total of 31 samples) showed 48% to be very excessive (over 6 mg./l.), 26% excessive (4-6 mg./l.), 26% high (2-4 mg./l.) and 0 low (below 2 mg./l.); in the blending plants (total of 60 samples), 3%, 22%, 50% and 25%, respectively. Other hazards, such as NH_3, H_2SO_4, use of dynamite, were also considered.

166. Patno, M.E.: Geographic study of cancer prevalence within an urban population. Public Health Repts. (U.S.) 69:705-15, 1954.

Pittsburgh, Pa. was divided into 16 homogeneous areas and data collected to study the differences in the distribution of cancer morbidity according to age, sex and race. The basis for the selection of the geographic areas, the population base used and the methods of analysis and results are discussed. Tables 1 and 2 show the population and the cancer prevalence/100,000 according to 5 age groups for the 16 areas for white males and white females in 1947.

Area 1, with the lowest socioeconomic status, the highest proportion of nonwhites, and the greatest number of foreign-born persons, had the highest cancer prevalence (43% higher than the rest) and mortality among white males of the whole area. Both white and nonwhite females experienced high prevalence and mortality. The non-white males' rate, however, was lower than that of the other areas. Prevalence of cancer of the skin and respiratory system was especially high among the white males, that of the buccal cavity, pharynx and "other" sites was relatively high, that of the genital and digestive organs average and that of the urinary organs lower than the rest. Cancer prevalence for nonwhites between area 1 and all the other areas is compared according to age group and to primary site. Area 2, with a high socioeconomic status, had the second highest prevalence rates for white males and highest for white females. Highest rates were for breast cancer and then for cancer of the digestive organs. The 2 areas of lowest prevalence, areas 15 and 16, were both of low socioeconomic status, but with fewer nonwhite and foreign-born people than area 1. Area 8, predominantly an Italian section, experienced the lowest rates for white men for cancer of the digestive organs, both in prevalence and mortality. This has been noted before for Italian-born males.

Air pollution as a possible cause of the high rate of skin cancer and cancer of the respiratory system in area 1 is argued against because

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(1) the air pollutants in previous smogs spread over a wider area and became more concentrated in a part of area 16 and (2) these pollutants would certainly affect the white women and nonwhite men and women as well as the white men of the area. The relationship of socioeconomic factors to the number of cases of cancer diagnosed, and thus to the prevalence rates, is discussed, but no significant relationship could be established.

167. Pemberton, J. and Goldberg, C.: Air pollution and bronchitis. Brit. Med. J. 2:567-73, 1954.

The crude death rate from bronchitis shows a steady and marked increase in passing from rural areas to towns, cities and conurbations in 1951: 69.4 -132.1/1,000,000 for males and 47.3-73.7 for females. Since air pollution was thought to be a possible cause of this increase, the relationship of the bronchitis mortality rates for men and women aged 45-64 and 65+ with air pollution, as indicated by SO_2 content and total solid matter content of the air in county boroughs of England and Wales, was statistically evaluated for '50, '51 and '52. However, the air pollution recording stations were not always placed to record average conditions, making the results somewhat dubious. Statistically significant correlation was found between the average SO_2 content and mortality rates in men in both age groups for all 3 years; such correlation occurred only in women aged 65+ in '51 and '52. There was no significant association between the average SO_2 pollution and the general social conditions, as measured by 2 indices - 1 based on income and 1 on housing conditions. A significant correlation between air pollution from solid matter and bronchitis mortality rates occurred only in men aged 45-64 in '51 and '52 and aged 65+ in '52 and in women aged 45-64 and 65+ in '52. It is concluded that SO_2 pollution may be a factor in determining the magnitude of the bronchitis death rates of middle-aged and elderly males.

168. Portheine, F.: Kohlenoxyd und Verkehr. (Carbon monoxide and motor traffic.) Arch. Gewerbepathol. Gewerbehyg. 13:253-61, 1954.

A comparison of the following figures gives a striking picture of the increase (100%) in German motor traffic: in 1939, Germany had 3.4 million cars; in 1953, there were 3.5 million cars on the road in West Germany alone. In traffic accidents in 1952, one person/5 min. was injured and 21/day were killed, while in 1953, 38/day were killed. In addition to the increasing motor traffic density, many deaths and accidents are caused by the consumption of alcohol before driving or by the action of alcohol and CO. The CO content of exhaust gases plays an important role in the air pollution problem, particularly in cities. Its effect on the central nervous system, when inhaled, leads to headache, fatigue and vertigo. Blood tests of car drivers, carried out in 1953 in West Germany, showed CO-Hb values of 8-12% with maximal values of 20%. It is stated that 4-cycle engines (Otto motors) have a CO content 10 X greater than diesel engines in their exhaust gases, and that producer gas (CO content 19-30%), which had caused so many injurious effects in the Scandinavian countries during the 2nd World War, is now almost out of use. On the basis of his own findings and of other authors' reports, the author gives the following values of CO content of exhaust gases: with choked carburetor - 11-13%, with exhaust adjustment - 6.4%, with good - 2.0 and finally with excellent adjustment - 1.2%. With idling motor, it is 0.355. Since even a small motor has a CO output in its exhaust gases of 30 l./min., the air in a garage is easily contaminated, especially in winter, when the motors often are "warmed up" inside the garage before opening the door. Besides, there is a reduction of both the tolerance of the poisonous effect of CO at a given blood level and of the amount of CO necessary to produce a

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certain CO-Hb level in the blood. The following figures are given as representing the CO content of city air (all figures as % by volume): Paris city (1940) - 0.003; at different heights of the Eiffel Tower - 0-0.0015; Dresden (1933) - not surpassing 0.021; Berlin (1930) - 0.01-0.02; in the Elbe river tunnel in Hamburg (1930) - 0.005-0.02; on highways in West Germany (according to recent determinations) - 0.003.

The drivers are exposed to the inhalation of CO from exhaust gases deriving from 2 sources, i.e., to the CO content of the motor exhausts from other cars and to that of his own car which either might be blown back into the car or might enter the car through leaks in the motor or in the exhaust pipes.

At a distance of 30 cm. from the exhaust pipe, the exhaust gases are diluted to a concentration of only one-tenth of the original concentration.

The author includes several case reports and an extensive bibliography. He adds that, apart from the drivers, the persons especially exposed to the CO coming from motor exhausts are traffic policemen and also babies in baby carriages who, when taken around by their mothers in the city streets, have their breathing level just at the dangerous level where the exhaust gases leave the pipes.

169. Quebedeaux, W.A., Jr.: Air and stream pollution control in Harris County, Texas. Public Health Repts. (U.S.) 69:836-40, 1954.

Since the war many industries have developed along the Houston ship canal, causing a great deal of air pollution in the area. According to a report from a physician in the area, there was an increased incidence of bronchitis. The people of Greens Bayou petitioned the Texas State Dept. of Health to do something about it. The gulf coast area is flat with predominant prevailing winds and temperature inversions occurring 180 days out of the year. This makes the usual stack height formulas unapplicable and necessitates collection of the pollutants at the plant. Committees in the local areas organized to obtain pollution abatement through various State agencies. The agencies, in turn, investigated the situation and set up a program for pollution abatement. Many plants cooperated and found markets or new uses for much of the waste they collected and had formerly thrown away. Reorganization in the Health Dept. at the end of 1953 interrupted much of the progress, but by early 1954, the dept. had established further abatement of air pollution and is looking forward to further success in the future.

170. Randolph, T.G.: Allergic type reactions to motor exhausts. J. Lab. Clin. Med. 44:912 (Proc.) 1954.

"Inhalation of the exhausts of Diesel-burning motors constitutes the most troublesome and hazardous exposure, especially to people clinically intolerant to petro-, chloro- and/or sulfo-chemicals, but by volume the exhausts of non-Diesel liquid fuel-burning motors contribute more significantly to metropolitan air pollution.

Relatively heavy automotive exhausts rarely extend above the 20th floor as the cause of symptoms in Chicago, being most concentrated in areas at street and below street levels, on humid, rainy or nonwindy days or in the presence of atmospheric inversion. Exposures are generally greatest when multilaned traffic grinds to a stop-light halt, for decelerating exhausts not only contain relatively more noxious uncombusted hydrocarbons, but compactness of tandem and adjacent vehicles limits dispersion.

Susceptible persons may develop rhinitis, coughing, headache, nausea and abdominal cramps, or cerebral reaction. Headache is the most common, but brain dysfunction is more dangerous, minor reactions often resulting in accident proneness, and greater ones to 'going to sleep at the wheel' and

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Randolph, T.G.: (continued)
'drunkenness' sans alcohol. Similar reactions may account for certain dopey, indecisive, uncoordinated pedestrians wallowing in a gaseous haze of motor exhausts, coal smoke and other metropolitan industrial pollutants.
Avoidance of diesel routes, driving windward in multilaned traffic and stopping with a car's gap between vehicles is helpful, but venting of diesel exhausts upward, employing more refined fuels and designing automotive cowls to prevent exhaust scooping are needed." (Condensed author's abstract).

171. **Savara, B.S., Noyes, H.J. and Suher, T.:** Effects of airborne fluorides on children living on Sauvie Island. J. Am. Dental Assoc. 49:39-45, 1954.
Preliminary studies, reported in 1949 by the Agricultural Experiment Station (Preliminary results of fluorine investigation involving dairy cattle and certain vegetative plants in Multnomah and Columbia Counties, Oregon) and in 1949-50 by M.P. Chapman (Fluorosis symptoms in cattle, Multnomah and Columbia Counties, Oregon; Agricultural Experiment Station, Oregon State College, Progress Report) (typescripts) showed that high concentrations of F's were present in the crops grown on Sauvie Island, Oregon. This Island is about 17 miles long, 4 1/2 - 5 miles wide. The nearest Al plant, in Vancouver, across the Columbia River, about 1 mile SE from the island has been in operation almost continuously since May, 1941. Up to 1945, the F's escaping into the atmosphere averaged 7,000 lbs./day. After a monitor spray system was installed in 1945, the amount was reduced to 3,600 lbs./day, and a further reduction to 1,100 lbs. was realized in 1949. Of 189 residents, 128 persons used locally produced beef and other meats almost all the time, 160 persons used fresh and frozen, locally grown vegetables all the time and 124 used their own canned vegetables. Lunch eaten by children at school was prepared chiefly from local products. All persons questioned were using H_2O from their own wells (less than 0.1 ppm F). Among the 68 children examined or 98% of the child population between 3-18 years of age, 54 were residents and 14 transients (the latter were used for controls). None of the children had mottled teeth; white opaque spots were seen in the upper incisors of 3 resident children. The def (decayed, erupted and filled) rates were similar to those of Portland nursery children; the caries rates for Sauvie Island children were higher than for Hagerstown, Maryland children. Hypoplastic defects were seen in the teeth of 1 child. Intra-oral roentgenograms showed normal resorption in 74%. Calcification of permanent teeth was normal in 53.7%, advanced in 33% and retarded in 13%. Eruption of teeth was normal in 70%, advanced in 22% and retarded in 7.4%. Ground sections from some teeth which had calcified during the period of the escape of the greatest amount of F's into the air were examined histologically and revealed no evidence of abnormal calicification. Roentgenograms of the hand and wrist, elbow and knee examined by 2 radiologists did not demonstrate any bone changes that could be attributed to F intoxication. The physique of the children as assessed from Wetzel's grid and Meredith's charts indicated that the majority of the children were in good health. The conclusions are that the findings and observations of the study indicate that the children of the Island show no symptoms - determinable by the methods used - of having consumed excessive F's in the past few years.

172. **Smithard, E.H.R.:** The 1952 fog in a metropolitan borough. Monthly Bull. Ministry of Health and Public Health Lab. Service 13:26-35, 1954.
The effects of the 1952 fog on Lewisham Borough in SE London are analyzed. This borough (population-227,000) is mainly residential with some light industry, a large gasworks and numerous railway lines. Pollution results mostly from combustion processes, mainly from the gasworks.

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Smithard, E.H.R.: (continued)
Unusual conditions preceded the fog. Subnormal temperatures occurred throughout autumn with below normal averages of 4.2°F.-Nov. and 3.4°F.-Dec. and rainfall was excessive: 153%-Sept. and 122%-Nov. Fires were lit early during the autumn and a good deal of "nutty slack," a potent source of smoke, was used to keep fires banked during the night. An increase in sickness was also noted in Nov., 1952 in comparison to 1951 and 1953. During the inversion period there were no stations in the borough estimating the daily smoke or S pollution of the atmosphere, though other stations located throughout England showed great increases, especially in Greater London. 228 deaths occurred in the borough in the 2 wks. ending Dec. 13 and 20 as compared with 76 and 95 for 1951 and 1950, respectively. 129 of these occurred from Dec. 6-11. In all 130 males and 98 females died, giving a ratio of 133 M - 100 F which is considerably higher than the usual yearly ratio. 24% of the deaths occurred in the age group 45-65, 27% between 65-75 and 46% over 75. Social class did not seem to make any difference. 42% died of circulatory conditions, 41% of respiratory conditions and 17% of other conditions. Compared with the corresponding %'s for the whole of 1952, i.e., 48, 14 and 38, respectively, respiratory conditions as cause of death show the greatest increase. Pathological examinations indicated that the great majority of deaths occurred in people with pre-existing lung and heart trouble. An uneven distribution of deaths between the 2 main registration districts was found; the ratio of deaths was 100 in Lee to 145 in Sydenham. This could not be fully accounted for. An analysis of the statistics by wards indicated that the wards with the highest mortality were in proximity to sources of excessive smoke.

173. Stanford Research Institute: The Smog Problem in Los Angeles County. A Report on the Nature and Causes of Smog. Los Angeles, Calif., Western Oil & Gas Assoc., 1954, 134 pp.

The General Picture

Smog in Los Angeles is severe and frequent because of the surrounding mountains and characteristic prevailing weather patterns which cause stagnation of the air over the area. The air over Los Angeles is comparatively low in smoke and dust and high in gaseous organic materials. The unusually large amounts of O_3 present in the air react with harmless materials (e.g., hydrocarbons) to form troublesome compounds that cause many of the undesirable effects of the smog, viz., eye irritation (aldehydes - chief cause), reduced visibility (tiny solid particles and liquid droplets floating in the air) and crop damage. Contamination is caused by the incomplete combustion of over 50,000 tons/day of gasoline, natural gas, oil and trash and by the evaporation of gasoline, paints, solvents and other volatile chemicals.

What is Different about Los Angeles?

Los Angeles is surrounded by mountains on 3 sides, and on the 4th by the ocean with an on-shore wind, making a virtual wall around the basin. A mass of warm air from the ocean frequently settles above the city, causing temperature inversion when the cool winds from the Pacific blow over the city - approximately 260 days/yr. These conditions make the escape of smoke and of other pollutants almost impossible, and thus allow the pollutants to react with one another under the influence of sunlight. With the inversion layer at 1,000 ft., complete air change takes as long as 24 hrs. Further, the tremendous rate of growth of Los Angeles makes a continually increasing problem.

Ozone in the Atmosphere

Measurements of the O_3 concentration of the Los Angeles area made at Pasadena showed consistently high values of 20 - 40 pphm (parts per hundred million) during smog (highest on the earth), but <5 pphm during no

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Stanford Research Institute: (continued)
smog, all of which are high values in comparison with other communities where measurements have been done. These measurements also showed a uniform diurnal pattern of O_3 concentration rising at 8:00 a.m., gradually attaining a maximum during the midday, then falling off slowly toward evening and becoming essentially 0 at night, similar to the pattern of human activity. It was low on windy and on heavily overcast days and highest on sunny, calm, windless days, when smog was also likely to occur. Oxidant recorders were also operated simultaneously in Pasadena and downtown Los Angeles. 2 types of records were obtained; 1 in which the 2 patterns were essentially alike (therefore, smog of local origin) characteristic of summertime, and the other which showed a time lag between the peak concentration of O_3 at Los Angeles and at Pasadena (smog evidently blown in from Los Angeles) characteristic of the winter months. 4 recorders were operated simultaneously at Pasadena, downtown Los Angeles, Monterey Park and Dominquez area showing very similar patterns of wind transporting the O_3 already formed and dissipating it by displacement and dilution. High O_3 concentrations (15-25 pphm) were also found at the outlying areas of Lancaster, Morongo Valley and Point Dume, but these were not necessarily associated with visible air pollution in Los Angeles.

In the study of the relationship of O_3 to the manifestations of smog, the summer months, July - Nov.'52, were considered separately from the winter months, Dec.'52 - Feb.'53, since the meteorological conditions differed considerably. Over-all inversion normally exists over the Los Angeles basin during the former period, but is absent in the winter. When plotting the O_3 concentration vs. visibility, excellent correlation appears for the summer period, but the values are quite scattered for the winter graph. Correlation for both periods is very good for O_3 concentration vs. plant damage, showing no plant damage below 10 pphm O_3 and the expected damage for O_3 above 25 pphm. For O_3 concentration vs. eye irritation, the correlation for winter is poorer than for summer with no complaints of eye irritation below 25 pphm O_3 and many complaints above 35 pphm. These data show the O_3 concentration to be the best available objective index of the various aspects of smog.

The methods used for the detection of O_3 in the atmosphere are evaluated. All the methods supported the conclusion that the bulk of the oxidant at Los Angeles is O_3.

The effect of meteorological variables on the occurrences of O_3 was shown by the following correlations. Daily maximum O_3 concentration decreased with increase of the total daily wind movement (in all directions). Wind speeds of 4-6 mph practically eliminated the formation of O_3. No quantitative relationship between the height of the base of the inversion layer and the intensity of the O_3 concentration (and therefore, of smog) could be noted. The O_3 concentration was found to be influenced by the sunlight intensity during the early and late parts of the day, but during the middle of the day sufficient sunlight is available to form all the O_3 of which the polluted air is capable. A statistical evaluation was made of these factors affecting the formation of smog, viz., inversion height, wind movement and incident sunlight and also of visibility. The calculations showed all the single correlation coefficients to be significant except that of O_3 and inversion height. The partial correlations made for the 5 variables showed all the quantities of the same order of magnitude except O_3 vs. sunlight, when values taken at 1:00 p.m. (sunlight abundant) and O_3 vs. height of inversion, when values were taken at 9:30 a.m.

Various technics were applied to study the vertical distribution of O_3. However, no meteorological mechanism seemed to account for the unusually high concentration of O_3 over Los Angeles. Formation of O_3 on the ground level was next considered. The possibility of the production of O_3 by

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electrical discharge or atmospheric electricity was ruled out, by reason of the tremendous amount of electricity required to produce the high O_3 concentration. The largest source of O_3 seems to come from photochemical reactions.

Various photochemical studies of the Los Angeles atmosphere were undertaken in which a continuous stream of outside air (in Pasadena) was irradiated and the amount of O_3 formed recorded. The wave length range of the light active for O_3 production was determined at 3600 Å - 4000 Å. The level of O_3 produced by continuous irradiation of outside air was dependent on air movement and available light. In an extremely stable atmosphere and sufficient light, a high in O_3 concentration is reached in the midday and a low at night. On days of average turbulence, a high is reached in the morning, which drops to a lower level during the midday and afternoon, rises again in the early evening hours and falls to a minimum at night. In attempting to determine the mechanism of O_3 formation, it was found that its formation proceeds in the absence of NO_2, aldehydes and ketones and very little peroxides, that the O_3-forming materials are not retained by 5% NaOH or 5% H_3PO_4, that they are gaseous rather than particulate matter (PM), that they are largely retained by a 10" layer of activated C and are destroyed passing over Cu oxide at 760°C. and can be trapped at -180°C., stored and released from the freeze-out traps.

Chemical Reactions in the Atmosphere

A careful interpretation of the kinetic and photochemical data in the literature must be made in studying these chemical reactions since the major natural constituents present in high concentration and the contaminants present in low concentration differ in concentration by a factor of 10^4-10^6. These vast differences in concentration produce effects which are not usually encountered in experimental studies of chemical reactions. These effects are considered in detail in a discussion of the following types of reactions: 1. Reactions of oxides of nitrogen; 2. Reactions of sulfur dioxide; 3. Reactions of ozone with unsaturated hydrocarbons; 4. Photochemical reactions of aldehydes and ketones and of olefins; 5. Reactions of organic free radicals in the atmosphere; 6. Reactions involving particulate material.

Crop Damage

The effects of air pollution on vegetation were determined by controlled experiments.

Eye Irritation

Studies had been made of the eye-irritating effects of each of the substances identified in the air by dispersing them one at a time in a large chamber, exposing persons to them and recording the reactions. Substances tested were SO_2, SO_3, N oxides, various aldehydes, organic peroxides (including mixtures of peroxides from gasoline), aerosols having various particle-size distributions and products of the reactions of oxides of N and gasoline vapors at smog concentrations. No single contaminant was found to account for the eye irritation of the smog. Studies of the effects of various combinations of the contaminants were then made by exposing in pairs a panel of 20-25 persons to artificial smogs in a similar chamber. Mild, moderate and severe sensations of smell, lacrimation and nose, eye and throat irritations were recorded and the results treated statistically. Two basic varieties of artificial smog were used. In one the aldehyde portion was made up of a mixture of aldehydes of known composition, and in the other the aldehyde portion was produced by allowing O_3 to react with gasoline vapors. The compositions of these smogs were as follows:

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Old Formula	Concentration	New Formula
Formic acid	0.04 mg./m.^{3}	-----
Formaldehyde	0.22 or 0.5 mg./m.^{3}	-----
Acrolein	0.01 mg./m.^{3}	-----
HNO_3	0.5 mg./m.^{3} (as HNO)	HNO_3
SO_2	0.5 ppm by volume	SO_2
SO_3	0.2 mg./m.^{3}	SO_3
Oil	0.5 mg./m.^{3}	Oil
PM (lampblack)	1.0 mg./m.^{3}	PM (lampblack)
O_3	0.35 ppm by bolume	O_3
NaCl	0.01 mg./m.^{3}	NaCl
	10.0 mg./m.^{3}	Gasoline

The following conclusions were reached (actually valid only for the artificial smogs; some may be true for the Los Angeles smog): 1. Atmospheres containing all of the major constituents of Los Angeles smog at the maximum concentration at which these constituents have been found in smog produced definite irritation of the eyes, but were not as irritating as some of the intense natural Los Angeles smogs. 2. Removal of no single constituent of artificial smog eliminated all of the irritating action. 3. Removal of all of the PM had little effect on the eye-irritating action of the artificial smog. 4. Removal of all of the gaseous constituents eliminated the eye-irritating action of the artificial smog. 5. The reaction products of O_3 and gasoline at concentrations which one might expect to find in intense Los Angeles smog produced much less eye irritation than either of the 2 artificial smogs. 6. The new formula artificial smog, in which the aldehydes are produced by the reaction of gasoline and O_3, seemed to have more nearly the odor and over-all irritating effect of natural smog than did the old formula smog.

Visibility Reduction

Particles were collected from the smoggy atmosphere by thermal precipitation, by impaction and by electrostatic precipitators. Both conventional chemical and spectroscopic analytical methods and specially developed microscopic technics, e.g., the use of a micromanipulator and micropipettes, were used to determine the composition of the particles. The concentration of particles in the air was estimated from the volume of air sampled and counts, using calibrated ocular micrometers, of the particles collected on the slides. Many, and often most, of the particles which decreased visibility during the smog were hygroscopic, acidic droplets containing organic material, $SO_4^{=}$'s and some other inorganic materials, and are surrounded by a tough envelope. Other particles decreasing visibility were PM ($\leqq$0.1 mg./m.^{3} air) composed of 60% minerals, H_2O-soluble crystals and other inorganic substances and 40% organic compounds, tars, C and pollen. The proportion of PM to droplets increased with decrease in relative humidity. Particle concentration in dense smog was estimated at 3,000-10,000 particles/m.^{3} and the average diameter at approximately 0.3 μ. Visibility ranges, calculated from the concentrations and diameters (calculated from the attenuation coefficient), were compared with visibility ranges measured photographically and were found consistent.

Visibility studies showed that the concentrations of various impurities might vary markedly and rapidly as the air mass moved. It is estimated that the different types of particles affect visibility roughly as: 1. hygroscopic liquid droplets - 30-80%; 2. C, tar and opaque particles - 10-50%; 3. transparent solids, some soluble and some insoluble/H_2O - 10-50%. During smoggy conditions, visibility generally decreased throughout the morning and increased quite rapidly in the afternoon. O_3 concentration

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was measured continuously as was the visibility, and low visibility was generally found to accompany high O_3 concentration.

Combustion of organic material produces a large amount of hygroscopic liquid droplets as found in incinerator smoke and automobile exhaust gases. Also the diurnal variation in visibility suggests that large quantities of droplets are formed by photochemical reactions occurring in the air in the morning. However, such reactions must be quite different from the reaction of O_3 and unsaturated hydrocarbons, or from the irradiation of mixtures of hydrocarbons and NO_2, since attempts to synthesize these droplets by photochemical reactions in the laboratory have resulted in quite different particles. The tarry and oily particles also result from combustion processes and possibly photochemical reactions, and the H_2O-soluble transparent solids, e.g., NH_4NO_3 and $(NH_4)_2SO_4$, of the PM are probably from combustion processes. The H_2O-insoluble transparent solids appear to be mainly soil minerals.

Emissions to the Los Angeles Atmosphere

Approximately 3100 tons of contaminants are emitted/day from activities of the general public, the petroleum industry and other industrial operations of which about 2660 tons come from the incomplete combustion of 50,000 tons of organic materials (waste) and fuel and approximately 440 tons come from the evaporation of hydrocarbons. Minor constituents are natural dusts, sand, metal particles, salt crystals from sea fog and a large variety of inorganic materials. Los Angeles does not have large amounts of soot, fly-ash or SO_2 from the burning of coal, and S emission from the petroleum refining field is suppressed by adequate measures. The pollutants from combustion processes are aldehydes (85 tons/day), NH_3 (14), oxides of N (463), S oxides (411), acids (157) and organics (1,534).

Automobiles were studied quite extensively, since automobile exhaust is the largest single source of pollutants. Analysis of the samples of the exhaust revealed hydrocarbons, oxides of N and S, aldehydes and PM as major pollutants. CO was discounted since it does not contribute to smog effects. 7% by weight of the gasoline fed into the automobile is emitted in the exhaust as an organic pollutant. The brand or type of gasoline burned, i.e., premium or regular, has little effect on the chemical composition of the exhaust. Automobile exhaust is the largest single contributor of oxides of N to the atmosphere; fuel oil combustion, the largest single contributor of SO_2; back-yard incinerators emit 400 tons daily of organic materials. Municipal and wood-waste incinerators emit insignificant amounts of pollutants.

1456 tons of hydrocarbons/day are emitted by combustion or evaporation to the Los Angeles atmosphere - 1180 tons or 81% from automobile operation (1016 tons in exhaust and 164 by evaporation), 62 tons from service station operation and 224 tons from gasoline production, refining and marketing. The total amount contains 330 tons of olefins which react readily with O_3 and thus contribute to plant damage and eye irritation. A comprehensive table of the emission estimates for 1950 and 1953 is given.

174. Thomas, F.W.: TVA air pollution studies program. Air Repair 4:59-64, 1954.
The air pollution control program, consisting of preoperational and postoperational phases, carried on by TVA is briefly described. Biological studies of the effect of the emitted SO_2 on the surrounding vegetation are included. Meteorological and air pollution instrumentation is discussed, and methods of reduction and analysis of data are described. Specific examples are cited to illustrate studies on effective stack height and diffusion. Information obtained indicates that the effective stack height and critical wind speed can be estimated with sufficient

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Thomas, F.W. (continued)
accuracy for practical evaluation of air pollution control requirements. However, W.T. Ingram and W. Davidson, in their discussion of this paper, state that the critical wind speed and effective stack height are also dependent on the number and type of surrounding structures, as in congested urban areas; F.W. Thomas did not take this into account in his calculations.

175. Wilkins, E.T.: Air pollution and the London fog of December, 1952. J. Roy. Sanit. Inst. 74:1-15, 1954.

This is a discussion of the air pollutants present during the Dec., 1952 London smog and their significance by the officer-in-charge, Atmospheric Pollution Section of the Fuel Research Station of the Department of Scientific and Industrial Research, London which cooperated in the investigation by collecting all available data on the concentrations of pollutants in different parts of the affected area.

The sources of air pollutants in town air, the meteorological conditions for fog formation and the methods used in the pollution measurements are reviewed. The daily smoke and SO_2 concentrations for Dec. 2-10, 1952 are tabulated showing maximum concentrations of 3-10 times the normal values for smoke and 3-12 times the normal for SO_2 to have occurred from Dec. 5-9 at individual sites as compared with the mean values for Dec., 1951. A comparison is made of smoke and SO_2 concentrations in London for Dec. 5-9, 1952 and Nov. 26 - Dec. 1, 1948 when severe smog also occurred. In general, the maximum and mean concentrations of both smoke and SO_2 in 1948 were about 50 and 70% of the 1952 values. A comparison of pollution in 1952 at the London sites, at sites in 7 towns which reported fog on 2 or more days during the smog period and at 8 towns which reported no smog showed appreciable increase of both smoke and SO_2 above normal even where no fog was reported. Probably, therefore, inversion conditions causing pollution increases were general even though there was no persistent fog in some of the affected areas. The greatest concentration of pollution occurred over the Westminister area with a zone of lesser concentration spreading along the riverside areas. The presence of other possible pollutants, i.e., CO, CO_2, H_2SO_4 mist and tar, which were not measured, is discussed.

The mortality of the period is discussed with a graphed illustration of the striking parallelism between the death rate and the concentrations of SO_2 and smoke. A secondary, but more extended peak in the mortality curve is noted for Jan. and Feb. Although others had attributed this to factors other than smog, including an outbreak of influenza, the author notes that during this period there was again a generally rising level of pollution to twice the normal value. He concludes that this was a second pollution shock to Londoners with resistance lowered by the earlier smog.

Since this smog was the most disastrous in the past 80 yrs., the question is raised whether it was due to freak meteorological conditions or to change in character or amount of any one pollutant or to both. Two factors are mentioned in this connection. One is the increasing concentration of SO_3 from both direct emissions and the oxidation of SO_2 in the atmosphere by the presence of oxides of N and certain types of particles acting as catalysts and O_3 with the subsequent formation of H_2SO_4 mist; all these reactions are favored during fog conditions. The 2nd is the exceptionally sticky or tarry nature of the grime which Londoners reported settled from the smog attributed to the increased use of a type of domestic open-fire designed to stay alight all night, and thus emitting smoke and distillation products at night.

176. Bloomfield, B.D.: Atmospheric pollution study of a non-industrial area. Am. Ind. Hyg. Assoc. Quart. 16:141-50, 1955.

The residents of the St. Clair River District and particularly of East China Township requested that an air pollution survey be made of their area

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Bloomfield, B.D. (continued)
which was the site of the Detroit Edison power plant under construction and of the proposed Michigan Iron and Coke Company plant. The survey was made from April 15 - May 15, 1953. 8 continuous air sampling stations for particulate matter (PM) were set up in the area, SO$_2$ concentrations were measured at 3 of them and dust counts were taken at each station; dustfall measurements were omitted because of too brief a sampling period. Descriptions of each sampling station and of the sampling equipment are included. Median values of PM for St. Clair and Marine City were 156.8 and 164.9 mg./m.^{3}, respectively; for the rural sites the values ranged 58.9-118.0 mg./m.^{3}. At station 24 in Detroit, a completely residential section with no industry within a 1-mi. radius and where similar sampling was being done at the same time, the median value was 195.0 mg./m.^{3}. The total weight of PM collected daily at each station is tabulated. A plot of the day-to-day comparison of the average of the 8 stations with the station in Detroit shows no decided similarity in trend. Plots of the day-to-day comparisons of the average with each station show a close similarity in peaks and lows. The data show that PM loadings increased with decrease in precipitation, but that there is little correlation of wind speed and air pollution levels. 60 of the 240 high volume air samples collected in the area were analyzed spectrographically for 22 elements; Ca, Si, Al, Mg, Pb and Fe predominated with median values of 9.35, 0.80, 0.75, 0.20, 0.80 and 0.70 mg./m.^{3}, respectively. Dust count determinations gave a median count of 0.9 million particles/ft. air, with a minimum of 0.2 and a maximum of 1.2 SO$_2$ concentrations ranged 0.02-0.08 ppm as compared with 0.05-0.10 ppm SO$_2$ in Detroit during May 7 - June 18, 1951.

177. California, State of, Department of Public Health: Clean Air for California. Initial Report of the Air Pollution Study Project. California, Dept. of Public Health, 1955, 60 pp.

The smog problem in principal California cities is discussed with some of the preliminary findings and recommendations. The nature and major sources of air pollutants are described and presented in tabular form. It is shown how the topography and meteorology of a mountain-ringed basin, such as Los Angeles, with its semipermanent inversion layer, can lead to an accumulation of smog. The relation of air and health is considered from several aspects: does air pollution cause illness; does it cause death; how much can we tolerate. A sickness survey, in which both the illness rate in Los Angeles from Aug. 2 - Nov. 28, 1954 among persons 65+ yrs. old and the incidence rates among persons of all ages for illnesses attributed to colds, asthma, hay fever and other respiratory conditions were compared to the level of smog, did not show any peaks in the rates coincident with high periods of smog. The rate of hospital admissions because of cardiac trouble, asthma and lung disease during Aug.-Nov. were also compared with high smog periods, but no correlations could be established. An examination of industrial absenteeism among approximately 6,500 workers showed that the absence rate did not vary significantly from the average rate for the period Oct. and Nov. The severe smogs that occurred in the Meuse Valley, Donora and London are briefly reviewed; these episodes clearly show the influence of polluted air on mortality. The possible effects of chronic air pollution on mortality was studied by comparing smog periods with Los Angeles deaths during Aug. through Nov., 1954, infant mortality rates and deaths in California nursing homes during Aug. through Nov. In only 1 case was there any correlation. During the week immediately following the heavy smog of late Oct., an unusually large number of deaths of people in nursing homes occurred. These data cover only a limited period and therefore more work needs to be done to determine if such a rise occurred in other episodes of smog. There is little information on how much air pollution we can tolerate

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California, State of, Department of Public Health. (continued)
MAC values are not applicable. The various known pollutants in the air are briefly discussed as to their occurrence in Los Angeles air and their physiologic effects.

178. Castrop, V.J., Stephens, J.F. and Patty, F.A.: A comparison of carbon monoxide concentrations in Detroit and Los Angeles. Am. Ind. Hyg. Assoc. Quart. 16:225-9, 1955.

The concentration of CO at street level in varied conditions of moving traffic and at 150 feet above main thoroughfares was determined in Detroit and Los Angeles. In both of these cities people depend more on private cars than on public transportation. However, the topography and meteorology in Los Angeles make this city much more vulnerable to atmospheric pollution. The method of collection of CO is described. In Detroit, 380 street level tests, made during Sept., 1952 and Oct., 1953, gave a mean value of 16.7 ppm and a maximum of 80 ppm for over-all traffic density. With heavy, medium and light traffic, the maximum concentrations were 80, 40 and 50 ppm, respectively, and the mean values were 28.9, 12.3 and 6.9 ppm CO. In Los Angeles, 398 tests were made during Sept. and Oct., 1954 and Nov., 1953. For heavy, medium and light traffic the maximum levels were 160, 85 and 60 ppm, and mean levels were 58.0, 27.5 and 11.8 ppm CO. The mean value on a nonsmoggy day was 9.7 ppm; on a smoggy day it was 39.4 ppm. The highest concentration detected, 160 ppm, occurred during smog. Though there has been a 3-fold increase in traffic, there has been approximately a 1/2 reduction in CO in the atmosphere since 1927 due mainly to engineering advances in reduction of gasoline consumption and CO content in the exhaust. In Detroit only 10 CO determinations were made at the 150 foot level. The values ranged from 0.5-3.0 ppm and averaged ca. 2.0 ppm. In Los Angeles, however, 157 tests, made from Oct. 2-14, 1954, gave results ranging from 1-15 ppm, with an average of 6.0 ppm. It is concluded that increased usage of automobiles has not increased the hazard due to CO.

179. Chambers, L.A., Foter, M.J. and Cholak, J.: A comparison of particulate loadings in the atmospheres of certain American cities. Proc. 3rd Natl. Air Pollution Symposium, Pasadena, Calif., April 18, 19, 20, 1955:24-32,1955.

This is a preliminary report on the program of high-volume air sampling and analysis of particulate material (PM) in more than 30 cities of the U.S. and Alaska made by the Robt. A. Taft Sanitary Eng. Center. Selection of cities was based mostly on factors believed contributory to air pollution, viz., geography, topography, climatology, industry, economics and other factors. Sampling was done at least once/wk. in each city and each sample represents the PM, in sizes $\geqq 0.3\mu$, removed from approximately 2,000 $m.^3$ air during a 24-hour period. The incomplete data obtained thus far in the survey are analyzed for loading distribution patterns. 2000 samples were analyzed for total PM, acetone-soluble material and proteins; 500 samples for Mn, Pb, Sn, Fe, Cu, Ag, Ti, V, Cr, Zn, Mg, Na, K, Sr, Be, As, F^-, Cl^-, $SO_4^=$ and <500 for NO_3^- and polycyclic hydrocarbons. The concentrations are given in $\mu g./m.^3$ The average concentrations of each of these in 5 cities having populations over 2,000,000, viz., Los Angeles, Detroit, Philadelphia, Chicago and New York, are compared. Values for total PM ranged from 188 (Philadelphia) - 344 (Detroit). Similarly, this comparison is made for cities with populations between 500,000-2,000,000, viz., Cincinnati, Kansas City, Portland, Atlanta, Houston, San Francisco and Minneapolis, with a range of 104 (San Francisco) - 176 (Cincinnati) and for selected small cities showing atypical loadings, viz., Anchorage, Charleston, Fort Worth and Louisville, with a range of 110-308. These concentrations as they occurred in the nonurban areas of Boonesboro, Salt Lake City, Atlanta, Cincinnati and Portland are also tabulated to indicate background levels

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Chambers, L.A., et al. (continued)
of PM. The following is discussed. Pb, which is possibly related to leaded automotive fuels, is relatively predominant in Philadelphia (9.5 μg.) and Los Angeles (5.2), but Los Angeles has almost twice as much acetone-soluble matter (57.3) as Philadelphia (30.0). Los Angeles has by far the highest amount of NO_3^- (14.4); San Francisco, the next highest, has only 3.4. The concentrations indicate, in general, that the total PM in the air over a community is related to the number of persons contributing to it. Certain small urban areas dominated by a single productive activity or strongly affected by special natural circumstances are exceptions. The frequencies of PM loadings are tabulated for each of the various-sized cities. For the cities over 2,000,000, the large majority of daily values fall between 150-500 $\mu g./m.^3$; for cities of 500,000-2,000,000 the values fall between 50-200; in rural areas, between 0-100. Seasonal distribution patterns are demonstrated by graph. The intermediate-sized cities show the most apparent winter-summer pattern; the larger cities show it somewhat, while the rural areas show no apparent pattern.

180. Cholak, J., Schafer, L.J., Younker, W.J. and Yeager, D.: Air pollution in a number of American cities. Arch. Ind. Health 11:280-9, 1955.
The interferences by SO_2, Cl_2 and NO_2 in the measurement of O_3 or "oxidant" concentration are discussed at some length and a method for calculating from the interference by SO_2 (the most serious of the 3) the maximum concentration of oxidant which could have been present is suggested. The observations of the concentration of oxidant, SO_2 and total $SO_4^=$ in 10 American cities, viz., Charleston, W.Va., Ann Arbor, Mich., Washington, D.C., Whiting, Ind., Cincinnati, O., St. Louis, Mo., Detroit, Mich., Philadelphia, Pa., Akron, O. and Elizabeth, N.J., are presented.

181. Clayton, G.D. and Giever, P.M.: Instrumental measurements of visibility in air pollution studies. Anal. Chem. 27:708-13, 1955.
The effect of meteorological phenomena and atmospheric particulates upon visibility was tested in the Detroit-Windsor area. The instruments used, i.e., the Transmissometer, the high volume air sampler and the Wilson automatic filter paper sampler, are described. The sensitivity of the Transmissometer was found to be adequate for measuring small variation in light transmittance. Visibility was greater in Detroit in the summer and fall than in the spring and winter. Light rain did not appreciably affect light transmittance, while heavy snows and rain caused a marked reduction. No relationship was found to exist between reflectance values of filter paper spot tests and visibility. Temperature anomalies had little or no effect on visibility or the aerosols that cause discoloration. Heavy persistent rain reduces the aerosols that cause discoloration. Snow does not reduce the aerosols that cause discoloration. No relationship was found to exist among visibility, mass weight and soiling power of aerosols. These results are illustrated graphically.

182. Department of Scientific and Industrial Research: The Investigation of Atmospheric Pollution. A Report on Observations in the 10 Years Ended 31st March, 1954, Report No. 27, London, H.M. Stationery Office, 1955, 207 pp.
This report summarizes the results of measurements of atmospheric pollution between Apr. 1, 1944 and Mar. 31, 1954, during which time some 1.5 million measurements of deposited matter, suspended matter (smoke), and SO_2 were made by a maximum of ca. 1400 instruments in many parts of the country. The measurements were undertaken by local authorities, public utility undertakings and other bodies cooperating with the Dept. of Sci. and Ind. Research. To allow for variations in pollution caused by meteorological variables, the data available for each site are averaged and compared for the 5-yearly periods of 1944-49 and 1949-54. Comparisons with

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Department of Scientific and Industrial Research. (continued)
1939-44 data are also made. The results are treated statistically. The deposited matter was determined by exposing approximately 600 standard deposit gauges for a period of 1 mo. at a time and then examining the solid and liquid fractions of the samples. For the period 1949-54, the average monthly concentrations were 410 g. total undissolved matter (ash, tar and other combustible matter)/100 sq. mi. in summer and 440 in winter, and 250 g. total dissolved matter (Ca^{++}, Cl^-, $SO4^=$)/100 sq. mi. in summer and 320 in winter. An average increase of 11%, that was statistically significant, occurred during the period 1944-54 (from the mean for 1944-49 to that for 1949-54). Suspended matter (smoke) was collected daily by D.S.I.R. filters or by Owens' automatic filters and the amount of smoke was estimated from the darkness of the resultant stain. The yearly average results for 103 sites ranged from $\leqq$1 mg./100 m.^{3} in some rural and coastal areas to ca. 50 mg. in some densely populated industrial areas; the average of the mean concentrations at all sites during 1949-54 was ca. 22 mg./100 m.^{3} Very high readings of 400 mg. sometimes occurred, mostly during periods of severe fog. The average concentrations at all sites during the 6 winter mo. was 2.3 X that during the summer. Also pollution during weekdays (Mon.-Fri.) was greater than at weekends (Sat. and Sun.) by ca. 30% during the summer and 20% during the winter. Smoke pollution decreased on an average of 30% from the period 1939-44 to 1944-49 and 15% from 1944-49 to 1949-54. S compounds were measured both by the "volumetric" and the"PbO_2"methods. Volumetrically the average concentrations at ca. 50 sites ranged from 1 ppm in rural areas to ca. 15 ppm in the most heavily polluted industrial areas, with an average of ca. 8 ppm for all sites. There was observed a fairly constant proportionality between the smoke and SO_2 concentrations. The average concentration of SO_2 at all sites was 2.2 X as high in winter as in summer; for smoke, the ratio was 2.3. Similarly at week ends there was a reduction in pollution by both smoke and SO_2, each to ca. 20-25%, as compared with weekdays. These seasonal and daily cycles are probably related to the reduced consumption of domestic fuel during summer and of industrial fuel during week ends. The yearly results of SO_2 measurement by the PbO_2 method at more than 600 sites ranged from 0.2 units at semirural sites to $\geqq$10 units in heavily polluted areas with an average of 1.5 units at all sites. The ratios of the results in winter to summer range from 1.5 in industrial areas to $\geqq$3 in some residential areas, with an average of ca. 2.0, which corresponds fairly well to the 2.2 ratio of the volumetric results. A general decrease in pollution of 1-7% is indicated by the 2 methods for the periods 1939-44 to 1944-49 and 1944-49 to 1949-54. 90 pages of detailed tables summarizing the results of the numerous observations made at all the sites throughout most of the 3 5-year periods are included.

183. Dettling, J.: Zur hygienisch-toxikologischen Bedeutung von aus dem Auspuff von mit bleitetraäthylhaltigem Benzin betriebenen Motoren. (The hygienic-toxicologic significance of lead dust contained in the exhaust of motors using tetraethyl lead gasoline.) Arch. Gewerbepathol. Gewerbehyg. 13:624-36, 1955.

The history of the use of ethyl fluid (TEL) (from 1923) and the investigations carried out in the U.S.A. on the safety of this use are discussed. Switzerland was the last of the countries of relatively large gasoline consumption to permit (in 1947) the use of TEL. The investigations carried out there under the auspices of the "Eidg. Bleibenzin-Kommission" (public health hazards and control of occupational hazards in mixing gasoline)and under those of the "Eidg. Materialprüfungsanstalt" (concerned chiefly with analytical aspects) during the past 8 yrs. are reviewed. The author has investigated the possible contamination of the atmosphere by TEL and its

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Dettling, J. (continued)

combustion products, especially on crowded roads, by estimating the Pb content of the dust. Pure TEL is never used in cars and airplanes, but as a mixture with ethylene halogens ("ethyl fluid"), the object being to avoid the deposition of PbO on the cylinders and to expel as much Pb as possible in the exhaust. In the presence of chlorinated and brominated hydrocarbons, pure TEL is decomposed into triethyl chloride or bromide compounds, which volatilize at 800°C. There is thus no danger of injury from the vapor of TEL but a potential danger from Pb dust and residues. The dust from the exhaust of an Opel car and an army jeep was examined by passing it directly from the exhaust on to a nitrocellulose film on the object holder of an electron microscope. Numerous solid globular particles, between 10 and 100 mμ in size (average 30.6 mμ for the Opel and 35.4 mμ for the jeep) with some aggregates, and a few larger white flakes representing rust and oil were observed. A control experiment with pure gasoline showed no globular particles. Radiographic and microchemical examination showed the presence of $PbSO_4$, insoluble in H_2O, $PbBr_2$, soluble in H_2O (about 9%) and probably some PbO. The total amount of dust was 1.25-1.50 mg./m.^{3}, and its Pb content 0.3-0.6 mg./m.^{3}. This was a smaller amount than that found by chemical determination in 1950 when the Pb content was 8.3 mg./m.^{3}. The difference is explained by the fact that in the filter method used in this investigation, particles exceeding 5 mμ in size are excluded, suggesting that the chief constituents of the dust are finer than the granules observed by the electron microscope, and this fine particle size may indicate the danger of deposition in the bronchial system. A comparison of the amount of Pb in the dust of streets bearing heavy traffic and field roads showed a content 100 times higher in the former, but this was small in comparison with the dust of Pb producing plants and garages. (From Bull. Hyg. 30:991, 1955.)

184. Elliott, M.A., Nebel, G.J. and Rounds, F.G.: The composition of exhaust gases from diesel, gasoline and propane powered motor coaches. J. Air Pollution Control Assoc. 5:103-8, 1955.

Exhaust-gas samples were obtained from diesel, gasoline and propane-powered motor coaches of similar passenger capacity under idling, accelerating, cruising and decelerating driving conditions. The samples were analyzed for CO, oxides of N, CHOH and hydrocarbons. In addition, the exhaust-gas flow rates were measured to permit calculation of the emission rate for each constituent at each driving condition. Based on a typical city driving pattern, it was concluded that: (1) The CO emission from the diesel coaches was only a small fraction of that from the gasoline and propane coaches; (2) The differences observed in the emission of oxides of N, CHOH and hydrocarbons by the 3 coach types were relatively small. No one coach type discharged either the greatest or least amounts of all of these 3 constituents. For example, the gasoline coaches produced the least quantity of oxides of N; the propane coaches, the least CHOH; the diesel and propane coaches, the least hydrocarbons. At the other extreme, the propane and diesel coaches produced the greatest quantity of oxides of N_2; the diesel coaches, the most CHOH; the gasoline coaches, the most hydrocarbons.

185. Falk, H.L. and Kotin, P.: The fate of polycyclic aromatic hydrocarbons in soot following their emission into the atmosphere and deposition in the lungs. Proc. Am. Assoc. Cancer Research 2, No.1:15 (Abst.), 1955.

The aromatic hydrocarbon content of soot-polluted atmosphere was found to differ qualitatively and quantitatively from gasoline and diesel engine exhausts. One atmospheric hydrocarbon was traced to incinerator soot and

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rubber tire dust. In view of the high concentration of 3:4-benzpyrene and the absence of certain source hydrocarbons from the atmosphere, a study was undertaken to determine the fate of these compounds. Aromatic hydrocarbons were absorbed on filter paper to determine the effects of air and light and synthetic smog upon them. The destruction rate of these compounds varied from complete to only 20% following a 48-hour exposure to air. Synthetic smog similar to that detected in urban atmospheres attacked the hydrocarbons at varying rates. No qualitative difference was observed in the destruction of the exposed hydrocarbons either in their pure state or when adsorbed on soot. These experiments resolved the qualitative and quantitative differences in the hydrocarbons at their source and in the atmosphere.

An analysis of the lungs of the average city dweller reveals the presence of approximately 1 g. of soot recoverable at autopsy. The soot thus obtained was measured gravimetrically. Spectrophotometric analysis of the recovered soot failed to reveal the usual aromatic hydrocarbons. The presence of the less stable carotenoids pointed to the actual absence of aromatic hydrocarbons. The absence of aromatic hydrocarbons was further substantiated by adding up to 40 μg. of hydrocarbons to the extracted soot, followed by quantitative recovery of these amounts.

The rate of removal of aromatic hydrocarbons from soot deposited in the lungs of mice is now under study.

186. **Firket, J., Desoignies, G., Elias, S. and Trabert, P.:** Les problèmes médico-sociaux que pose l'augmentation de fréquence continue des cancers du poumon. (Medico-social problems arising from the increasing incidence of lung cancer.) Arch. belges méd. sociale, hyg., méd. du travail et méd. légale 13: 375-91, 1955.

This is a report on an investigation carried out by the Provincial Laboratory of Liège from July, 1952 to Oct., 1954. 589 cases of primary pulmonary cancer (566 M, 23 F) were diagnosed both cytologically and histologically. The following types of cancer were detected: epitheliomata, 78.8%; anaplastic cancer (undifferentiated), 17.7%; cancer of the bronchial glands, 1.0%; adenocarcinomata, 0.6%; unclassified, 1.9%. Concluding from the high cancer incidence in an area with a population of 900,000, the author calculates that, at the present time, the annual number of cases in Belgium is about 6,000. Although publications on the subject demonstrate that there is an over-all increase in lung cancer incidence, there is not yet sufficient scientific evidence of a predominance of the occurrence in industrial, as compared to rural, areas. Lung cancer occurs most frequently in factory workers. The unequal sex distribution, clearly demonstrated in the 589 cases examined by the author, cannot yet be explained. An attempt to evaluate the possible reasons for the notable over-all increase in lung cancer incidence is introduced by a discussion of certain principal factors in cancer development, particularly with regard to the time element. Some authors' claims that existing infections and inflammatory diseases might have a predisposing influence are discussed. From figures published by the Solvay Institute of Sociology the tobacco consumption in Belgium showed a steady rise until 1950 but has not increased since. Cigarette smoking is recognized as a predisposing factor in the development of lung cancer. During the past 50 years, atmospheric pollution has been steadily increasing. In 1931, the S content of freshly fallen snow was 10 times that determined in 1899 by the same method, at the same areas in the Meuse Valley. The influence of meteorological and geographical conditions, as well as the distribution of both industry and lung cancer incidence and possible relationships are reviewed. In certain industrial regions, spectrophotometric analyses of the atmosphere have shown the presence of benzpyrene adsorbed on particles of soot.

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The incidence of lung cancer was greatest in those areas where, due to the prevailing wind, pollution by dusts was concentrated. It was lower in the center of towns than at the periphery, where the working class population lives in crowded areas, and the workers themselves are exposed to contaminants in the factories.

187. Fowler, R.: Some observations on the epidemiology of lung cancer. Med. J. Australia 1:485-94, 1955.

In commenting upon epidemiological aspects of lung cancer in the Australian community, reference is made to (i) national mortality statistics, (ii) clinical statistics from the Central Cancer Registry, Melbourne and (iii) selections from current medical literature. It is found that in Australia the incidence of lung cancer (bronchial carcinoma) is increasing at a uniform rate -- 7.7%/yr. for males and 4.6%/yr. for females. The rate of increase differs from that in other countries, but the exponential pattern is the same. Reasons are given for the opinion that the increasing frequency is largely independent of improved methods of diagnosis and of changes in the age composition of the population; a significant part of the increase is due to cumulative pathogenic forces which are almost certainly environmental in origin. The importance of this conclusion is that it holds out hope for prevention. Methods of epidemiological control are considered under 2 main heads, (i) curative measures and (ii) preventive measures. A detailed analysis of the clinical features of 1000 case histories illustrates the difficulties of early diagnosis and the limitations of ablative surgery in dealing with overt cases of the disease. An account is given of case finding by mass radiography in the State of Victoria. The evidence from Britain and the U.S.A. which incriminates smoking as a lung cancer pathogen is regarded as convincing. The smoking habits of Australians are described and are thought to be consistent with the theory that habitual heavy smoking is similarly blameworthy in this country. Mention is made of the classical instance of occupational lung cancer in miners of Ni, Co and U ores in middle Europe. This particular hazard is of considerable interest to Australia at the present time, when U fields are about to be exploited. (Author's summary.)

188. Guiliani, V. and Belli, R.: (Carbon monoxide. Presence in the air of cities and the possibility of poisoning.) Folia med. (Naples) 38:238-48, 1955.

The CO in the air of streets, squares, tunnels and places with heavy traffic, in industrial zones and in the periphery of Naples was studied. Toxic concentrations were not observed. Persons exposed occupationally for many hours to the highest concentrations showed a CO content in the blood within physiological limits and no case of poisoning is on record. (CA 49: 9848, 1955.)

189. Hemeon, W.C.L.: The estimation of health hazards from air pollution. Arch. Ind. Health 11:397-402, 1955.

Solid aerosols are the only community air pollutants of significance in affecting human health (except perhaps SO_2). The sampling of these particles is difficult in that the larger size particles which are irrespirable are usually also collected, but exert only a diluent effect, thus giving erroneous compositions. Filter paper sampling which measures the amount of pollutants by the extent of light transmission is more informative, since the finer particles only are responsible for the scattering of light. This method should be useful in chronic exposure studies.

Some 50-75 g. of smog solids from the week of the severe smog in Donora (1948) were obtained from a home electronic air filter. A partial analysis of these solids showed 40% C, 10% S (as SO_3), 9.7% Zn (ZnO) and lesser

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Hemeon, W.C.L. (continued)
amounts of other constituents. Spectrographic analysis for metal showed very low %'s for metals with Fe, Al and Si 5-15%, and Zn, Ca and K 1-10%, the rest being less than 1%. Upon calculation of the adsorptive power of the particles, it was found that the amount of SO_2 possibly transported would $\leq$0.1-0.2 cc./24 hrs., thus lower than irritating value. However, examination of the H_2O-soluble fraction (22%) of these solids chemically and by X-ray diffraction disclosed large quantities of $Zn(NH_4)_2(SO_4)_2 \cdot 6H_2O$ and $ZnSO_4 \cdot H_2O$ to be present. The solids removed from an air-cleaning filter in London for the mo. of Dec. '52 in which the severe smog occurred was also obtained and examination showed that 30% by weight was soluble/H_2O and rich in S (21% as SO_3), NH_3 and Cl^-'s with appreciable amounts of Na, K, Al and Mg. X-ray diffraction analysis showed principal constituents to be NH_4Cl and $CaSO_4$.

The sulfates and chlorides of NH_3 are known to be respiratory irritants and are believed to be the significant irritants of the 2 smogs. The SO_2 in the atmosphere in smog seems to be significant only in its formation of sulfates. All the constituents of these salts, i.e., NH_3, S, Cl^-'s and the various metals are common in coal smoke.

Though both of these samples collected are probably not representative of the respirable particles, the results obtained are considered to be of qualitative, if not of quantitative significance.

190. Hutchison, D.H. and Holden, F.R.: An inventory of automobile gases. J. Air Pollution Control Assoc. 5:71-4, 118, 1955.

It was estimated that 1016 tons of hydrocarbons, or ca. 1/3 of the 3000 tons of total organic contamination, are liberated into the Los Angeles atmosphere each day from automobile exhausts. 88% of the olefins and 37% of the N oxides found in the Los Angeles atmosphere come from this source. These amounts would result in concentrations of 0.25 ppm hydrocarbons and 0.06 ppm N oxides in the 240 mi.^{3} of polluted air in Los Angeles County. 5 pre-war and 5 post-war cars were selected at random to measure the amount of hydrocarbons released into the air by gasoline-burning vehicles under the 4 driving conditions of acceleration, steady driving, deceleration and idling. 20-40 samples of exhaust emitted during each driving condition were collected and analyzed with a mass spectrometer within 1-3 hrs. after being collected. It was found that there is a loss of hydrocarbons out of the exhaust ranging from 5% of the weight of the fuel entering the carburetor under conditions of steady driving to 19% during periods of deceleration. Emission of automobile exhaust hydrocarbons is estimated to have been >1000 tons/day in 1953 and ca. 600 tons/day in 1945. For return to the relatively smog-free days prior to 1945, total hydrocarbons emission should not exceed 600 tons/day. It is believed that devices can be built that will convert 60% of the unburned or partially burned hydrocarbons to inert gaseous products.

191. Katz, M.: Atmospheric pollution: A growing problem in public health. Am. J. Public Health 45:298-305, 1955.

A study of the air pollution problem of the Detroit River area has been undertaken. Daily measurements were made of the total weight of particulates collected by using high-volume sample filters at 32 sampling stations in Detroit and 25 in Windsor for ca. 6 wks. A large number of these samples were analyzed for Si, Ca, Al, Fe, Mg, Pb, Mn, Cu, Zn, Ti, Sn, Mo, Ba, Ni, V, Cr, Cd, Be, Sb and Co (in approximately decreasing order of concentration). Maximum concentrations for the most abundant elements were 20-38 $\mu g./m.^3$ air; concentrations for the last 5 elements were $< 0.1\ \mu g./m.^3$ On the basis of the collected data, high and low pollution areas were selected in Detroit and Windsor containing well defined population groups matched

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according to socioeconomic status and other factors in so far as possible. 2 towns containing no heavy industry or contamination from vessel smoke and situated within 40 miles of the Detroit River were selected as a control area. Regular visits at 2-wk. intervals to households in the area were planned. The information sought included: (1) a household record of general family and environmental data, including occupation and income levels; (2) a record of present health status and conditions prior to the initiation of the study, using a modification of the Cornell Medical Index; (3) current sickness data on individuals in the high and low pollution and control areas. In the late summer, 1953 the health study was begun and the data collected is being assessed by a small group of experts. A review of the available health data in the Detroit River area is also being made.

192. Larson, G.P., Chipman, J.C. and Kauper, E.K.: Distribution and effects of automotive exhaust gases in Los Angeles. S. A. E. Trans. 63:567-74, 1955.

Analyses were made on automobile exhaust gases to determine the concentration of hydrocarbons emitted from them to the atmosphere. Instantaneous samples were collected during idling, acceleration, cruising and deceleration under condition of freeway driving, residential driving, congested city traffic and industrial areas. The results of a typical analysis for each driving operation show the concentrations of hydrocarbons (C_3-C_9) ranging as 354-5125 ppm hexane, of acetylenic gases as 18-825 ppm C_2H_2, oxides of N as 8-4180 ppm NO_2, lower aldehydes as 88-1369 ppm CHOH, 0.0-3.6% CO, 6.1-13.7% CO_2 and 1.1-9.5% O_2. From this it is estimated that 850 tons of hydrocarbons/day enter the air in Los Angeles County from auto exhausts. Sampling for solid and liquid aerosols under idling conditions showed 35-50 tons particulates/day are emitted. Pollution from diesel exhausts is insignificant since so little diesel fuel is burned in comparison to gasoline. There seems to be less aldehydes discharged when liquid petroleum gas is used, though very little has been investigated on this subject. Experiments in test chambers showed that damage, typical of that found in the field after smog attacks was produced on all 5 indicator plants (spinach, sugar beets, oats, alfalfa and endive) when the exhaust gases and O_3 were introduced into the chamber at separate points. Borderline damage was obtained with 8.05 ppm gasoline vapor and with 5.46 ppm exhaust hydrocarbons. During these and other experiments, observations were made for eye irritation, which was noted in some experiments, and formation of aerosols. In 1 case using 4.3 ppm exhaust hydrocarbons eye irritation was produced when the aldehyde concentration was below the eye-irritating threshold known for CHOH. No actual measurements were made of the quantities of aerosols formed from a given amount of exhaust hydrocarbons. It was concluded that exhaust gases from gasoline engines are as effective in producing smog effects as is gasoline when both are oxidized in the presence of NO_2 and O_3. Studies were then carried out to determine the hydrocarbon concentrations in the atmosphere which might result from the emissions of auto exhaust. These clearly showed that removal of all other sources of hydrocarbons from refineries and from the distribution of gasoline will not lower the concentration of hydrocarbons in the downtown area and the northcentral section of the County sufficiently to relieve the eye irritation, crop damage effects and high O_3 content of the air in those areas. Based on the anticipated increase of population and additional freeways, it is concluded that removal of 90% of the hydrocarbon vapors from exhaust gases under conditions of operation experienced in heavy traffic will be necessary to decrease the hydrocarbon concentration from the early morning traffic to levels which can be tolerated in the Los Angeles atmosphere.

193. Lawther, P.J.: Some clinical aspects of the atmospheric pollution problem in London. Proc. 3rd Natl. Air Pollution Symposium, Pasadena, Calif., April 18, 19, 20, 1955:160-3, 1955.

This is an attempt to report briefly the progress of the work done on the air pollution investigation at St. Bartholomew's Hospital since 1950. Immediately after the 1952 fog, research was undertaken to prevent any recurrence of the disaster by devising means of protection. Investigations are or have been undertaken on masks, air purifying and neutralizing devices, the physical and chemical nature of contaminated fogs, particularly the solid components, carcinogenic compounds, effect of petrol and diesel emission exhausts on CO in blood, air pollution effects on animals in general and cattle in particular and the effects of daily pollutants on the respiratory resistance of patients with chronic bronchitis and emphysema. A warning system has been set up with the Meteorological Offices and other hospitals throughout the country for emergency service in the event of the occurrence of a thick fog that has a 50-50 chance of lasting for a day.

194. Lew, E.A.: Cancer of the respiratory tract. Recent trend in mortality. J. Intern. Coll. Surgeons 24:12-27, 1955.

This paper contains statistical data on the death rates due to cancer of the respiratory tract in the general population of the U.S. and among both industrial policyholders, i.e., urban wage earners of the lower income brackets, and ordinary policyholders, representing the middle and well-to-do classes engaged in nonhazardous occupations, of the Metropolitan Life Insurance Co. In the period from 1930 through 1953, the total number of deaths due to cancer of the respiratory tract in the U.S. increased 6-fold, i.e., from 3,900 to 27,000. Continuing at this rate of increase, it would amount to 40,000 in 1960. 50% of this increase can be attributed to the growth in population and in life expectancy, 50% to actual rise in cancer incidence, with the exception of white females who showed 60% increase. Deaths due to cancer of sites other than the respiratory tract - excluding leukemia and Hodgkin's disease - amounted to 114,000 in 1930 and 192,000 in 1953, at the following sex distributions: white: male - slight increase, female - 12% decrease, nonwhite: male - nearly doubled, female - 7% increase. Modifying factors, e.g., age, sex, race and region of residence, are discussed. As to cancer of the respiratory tract, the death rates reflect a predominant incidence in males $>$ 45 years and in females $>$ 55 years of age. The fatalities in males were 4-6 times higher than in females. With regard to races, the following increase in figures are given for the last 25 years: white, male - 5 X, female 2 X, nonwhite (during the period 1930-50), males over 45 years of age - 10 X and females - very appreciably. The ratio male : female in nonwhites was very similar to that in whites. Generally, the incidence was lower in classes having more access to medical care, i.e., ordinary policyholders. It was highest in urbanized, industrial states and lowest in rural and mountain states, the exceptions being Louisiana, Florida and Nevada, where it was also high. In addition to significant environmental factors, the following have contributed to the rise in the cancer death rates concerning the respiratory tract: the quantity and quality of medical care, more instruction of and publication for the population, better facilities and methods of detection as well as more reliable reporting. In the past, many deaths had been attributed to other causes, e.g., pneumonia or senility, or had been reported as associated or secondary condition.

195. Linsky, B.: Report to Detroit Common Council on emission of odor, smoke, gas, etc., from diesel-engined coaches. APCA News 3, No.8:1, 4, 5, 1955.

The smoke-emitting properties of diesel, gasoline and propane-powered buses are compared. Smoke results only from improper engine maintenance, improper engine adjustment or improper fuel. However, these precautions are not always heeded. Smoking gasoline buses usually put out more visible smoke when decelerating; smoking diesel buses put out more smoke when accelerating. Both of these are avoidable. More odorous gases are emitted when smoke is being emitted; however, they are also emitted without visible smoke by Diesels when accelerating and by gasoline engines when decelerating even when the engines are in perfect adjustment using the most proper fuels. There has been some technical work done recently and currently on the measurement of odor in engine exhaust gases. Exhaust gases from buses are not significant in area-wide pollution, particularly since buses are a small % of the motor vehicles. Localized effects in and near the bus, before any great dilution takes place, are the following: an odor from CHOH and other aldehydes; no odor from CO and CO_2; mild odor from exhausts from hydrocarbons and from oxides of N and SO_2. The diesel engine emits ca. 1/100 as much CO as the gasoline engine, emits no Pb compounds, 40% more N oxides, 40% more CHOH except when decelerating and 60% less hydrocarbons especially when decelerating. No detrimental effect on vegetation was found during studies of this phase for the past 2 yrs. Propane-fueled buses produce no Pb compounds, and are reported to stand between gasoline and diesel buses with respect to the emission of CO, oxides of N and hydrocarbons.

196. Mancuso, T.F., MacFarlane, E.M. and Porterfield, J.D.: The distribution of cancer mortality in Ohio. Am. J. Public Health 45:58-70, 1955.

An analysis of death certificate accuracy was made by determining the "confirmation of diagnosis" of 990 male (aged 25-64) deaths due to tumors of the central nervous system which occurred in 1944-1952; 80.2% were assuredly primary. The state rates for the various cancers by age show an increase in rates with age similar to that generally observed elsewhere.

A study of the geographical distribution of 12 cancer sites within the State of Ohio revealed differences in some sites, but not in all sites, and that the counties with large urban populations (especially Cuyahoga and Hamilton Counties) showed excesses in cancer mortality for the most part. The study of urban-rural relationship revealed that standardized mortality ratios (SMR) for cancer sites of lung, esophagus, buccal cavity and pharynx, larynx, tumors of the central nervous system and bladder for white males (25-64) increased with density of population: rural areas (population of cities <50,000) - SMR ranging 51-84; urban counties (population of cities ≧50,000) - 82-97; metropolitan counties (population of cities ≧100,000) - 110-133. There was no significant difference between metropolitan and rural counties for the cancer sites of stomach, pancreas, lymphatic and hematopoietic tissues, leukemias and prostate, SMR's ranging from 86-106.

For the 8 metropolitan counties in Ohio, a comparison of the white native and foreign born males, ages 25-64, revealed a significant excess ($P=0.001$) in lung cancer mortality among the foreign born; SMR for native whites = 91, for foreign born = 131. In Cuyahoga Co., a smaller geographical unit having the largest urban concentration, the characteristics found to be associated with an excess of lung cancer mortality were: foreign birth, low economic level and low education level.

The authors conclude that state health departments are missing an excellent opportunity to apply readily available death certificate data to the epidemiological study of cancer and other noncommunicable diseases.

197. Milmore, B.K.: Trend of lung-cancer mortality in the United States: Some limitations of available statistics. J. Natl. Cancer Inst. 16:267-84, 1955.

Statistics based on medical information recorded on death certificates and representing the mortality experience of the entire United States first became available in 1933. Prior to that date mortality statistics compiled and published by the U.S. Bureau of the Census reflect the mortality experience of the expanding Death Registration Area, which in 1914 comprised less than 2/3 of the population of the United States. States admitted to the Death Registration Area early in its development constituted a highly biased sample of the U.S. Their recorded mortality rates may be considered as the best available index to national mortality experience but must be interpreted with due regard to their limitations. In general, the United States has used decennial revisions of the Manual of the International List of Causes of Death as a basis for death classification. As a result of periodic revisions of this list and other changes in procedures for coding causes of death, exact comparability of mortality statistics is sometimes lost. This occurred in cancer of the respiratory system. Recorded mortality rates for cancer of the lung and for cancer of the larynx from 1914-1950 were standardized for age and further adjusted by means of comparability ratios in an effort to overcome some of the limitations discussed above. These comparability ratios take into account only changes in statistical cause-of-death classification procedures--not factors relevant to validity of death certificates, such as improvement in methods of diagnosis, nor the effect of the addition of new Death Registration States. For the years 1914 to 1948, these ratios for lung cancer mortality statistics fluctuate between 1.000 and 0.926. The lung cancer mortality rate for all persons in continental U.S. in 1950 (127.9/million) was 19 times as great as the corresponding rate for Death Registration States in 1914 (6.6/million). These states contained only 62% of the population of continental U.S. in 1914 and in recent years have had significantly higher lung cancer mortality rates than other states. The estimate of a 19-fold increase in lung cancer mortality in continental U.S. from 1914-1950 is therefore conservative. The equivalent annual rate of increase was 9.1% from 1914-1930 and 8.1% from 1930-50. The slight decline in rate of increase during the latter period is statistically significant ($P<0.01$). Between 1945 and 1950, the rate of increase for white males and nonwhite males rose again. In contrast, both white and nonwhite female rates of increase decreased. From 1930-1950, nonwhites experienced strikingly greater rates of increase in lung cancer mortality than the white population. The magnitude of the increase in recorded lung cancer mortality, persisting in almost exponential pattern for more than a 1/3 of a century, is unequaled by any other cancer site. For cancer of the larynx there was <2-fold increase in recorded mortality for the entire population between 1914 and 1950. Among white females, larynx cancer mortality declined between 1930 and 1950 to a point slightly lower than the 1914 rate.

198. Newbury, B.C.: The Sarnia Survey: Action without compulsion. Can. Chem. Processing 39, No.3:60, 62, 64, 66, 68, 1955; Am. Soc. Mech. Engrs. Paper No.55-APC-4, 1955.

The paper describes the events leading up to the formation of a cooperative investigation of air pollution in the Sarnia area. Six major industrial firms are contributing to the cost and actively participating in the survey which started Oct., 1952. A master sampling station is located in Tecumseh Park, an open space ca. 2 mi. E-NE of the major pollution sources in the more heavily polluted part of the residential area. It is somewhat off the direct line of the prevailing wind, but it is free from local influences. Other sampling points are located throughout the

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Newbury, B.C. (continued)
residential, commercial and industrial areas. Dustfall is found to be 65-100 tons/sq.mi./mo. in the industrial area immediately S of the city, 50-65 tons in a band surrounding this area and 35-50 tons in the residential area. Summer and winter values do not differ greatly, and a peak occurs in April and May. This is interpreted as due to the shipping and seasonal dock activities which coincide with the heating loads in April and May. It is calculated that the ships and docking activities contribute dustfall of the order of 20 tons/sq.mi./mo. Aerosol and SO_2 measurements are also being carried out. The pollution patterns of these components follow that of the dustfall. Meteorological studies indicate the great influence of wind on the SO_2 concentrations. In 1 instance, a wind reversal sent the SO_2 concentration from the normal high of 0.2 ppm up to 1.5 ppm in a few minutes. Information is exchanged freely and technical advice is given to the City's Air Pollution Committee in dealing with hospitals, schools, etc. The cooperation between industry and the public has led to much understanding and control of air pollution.

199. Peart, A.F.W., Anderson, C.P., Rabson, A. and McEwen, W.L.: Pretest of forms and field techniques for use in the Detroit-Windsor air-pollution study. Arch. Ind. Health 11:47-52, 1955.
The initial objective of the health study is to measure the incidence of symptoms and sicknesses which occur among persons exposed to various levels of pollution in the study area. The ultimate purpose of the study is to determine maximum permissible levels for chemical compounds in the air, which are not injurious to human health. 3 types of forms were selected for the study: (1) basic family and environmental data; (2) a record of current sicknesses among individuals in high and low pollution areas and (3) a record of the state of health, especially of the respiratory and digestive systems and of the skin, of the population prior to the study. Illustrations of these forms are given. A pretest of forms and technics, in which enumerators approached 70 families in Windsor and 50 in Detroit, was conducted from Feb. 2-Apr. 1, 1953. An evaluation of these forms and technics was then made by the use of a General and a Specific Evaluation Form, both illustrated. The response of household informants, even to lengthy questionnaires and personal questions, was quite good. However, a little advance publicity and an introductory letter to the householder would have assisted the enumerator in making initial contact with the household informant. A few questions pertaining to income and years of school training offended a few persons and should probably be left until the end of the study. There was some evidence that the enumerator training program was inadequate in some respects, as enumerators did not fully understand the objectives of the study and the purpose of the forms. It was also decided that the best time to visit households was in the morning, except on Monday, or afternoons and it was preferable to make appointments. A 2-week interval between visits was considered optimum.

200. Renzetti, N.A., (ed.): An Aerometric Survey of the Los Angeles Basin August - November, 1954. Report No. 9. Los Angeles, Calif., Air Pollution Foundation, 1955, 333 pp.
The status of the knowledge on smog in the area, as of spring 1954, is reviewed. For this Aug.-Nov., 1954 survey, 10 sampling sites were selected to be along typical surface wind trajectories for the period in question. A control station was located in Santa Barbara. Each station is described as to location, immediate surroundings and the instruments installed. Oxidant concentration and severity of eye irritation were measured at 10 stations, severity of plant damage at 6, oxides of N concentrations at 4, hydrocarbon, CO and aldehyde concentrations at 2, concentrations of

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Renzetti, N.A., (ed.). (continued)
various particulates at 2, SO_2 concentrations at 1 and visibility at 4. Oxidant and oxides of N concentrations were also measured aloft from a blimp. In addition, the Air Pollution Control District made observations on wind speed and direction, rubber cracking, temperature and relative humidity. The various instruments used in sampling the pollutants and measuring meteorological data are described and illustrated.

Eye irritation panels consisting of groups of 10+ office and/or factory workers, located adjacent to or near each sampling station, were set up during July and Aug. During Aug. and Sept. surveys were run Tuesdays and Fridays plus 1 other day, if smog was forecast, at a specified tine of day. During Nov., surveys were run only on days when a smog was forecast with individuals reporting the maximum irritation experienced during the day and the time at which this occurred. The eye irritation or smog sensitivity scale used to evaluate eye irritation is described in detail. The rater placed a mark on a line corresponding to the amount of eye irritation felt, i.e., none - some - moderate - severe - worst, or at some point in between. The linear distance from the reference point was computed in units (=0.1"), and the results of each of the subjects statistically evaluated. The values for none, some, moderate, severe and worst were arbitrarily set at 5, 15, 25, 35 and 45 units, respectively. An "expert" panel composed of Dr. Haagen-Smit and his coworkers was set up at the California Institute of Technology; a comparison of the mean values reported by this panel and by the "lay" panel on the same campus showed the "expert" panel's means were ca. 5 units less than those of the "lay" panel for the same days. The air pollution control district also conducted an eye irritation survey by placing a network of reporters of eye irritation near the stations. Reports were made by a single observer; where more than 1 observer participated, they conferred and reported a single value. The tabulated results by day and station are included. The advantages and disadvantages of the methods are compared. From the data obtained by the Air Pollution Foundation, those days with the mean severity above 25 units were selected and the percentage of this number relative to the total number of days sampled was calculated; from this the following results were obtained.

EYE IRRITATION VALUES

Station	Total Days of Sampling	% of Days Mean Severity above 25	Highest Value
Venice	22	5	25
Wilshire	33	42	40
Downtown	48	27	38
Pasadena	28	46	44
Burbank	28	58	39
Dominguez	21	10	25
Artesia	23	9	25
Rivera	33	36	38
Bassett	28	35	35
Azusa	27	44	38

The results when graphically displayed in relation to the typical air streams are consistent with the hypothesis that the pollutants, among which is the eye irritant, increase in concentration with distance traveled over source areas. If the days when the panels report values above 15 units for all 10 stations are averaged, the calculations show that at least appreciable eye irritation was experienced throughout the Basin 69% of the 29 days on which eye irritation was sampled. Higher levels of irritation were reported occuring earlier in the day than were lower levels. Recommendations for further improvement of the technics are given. The eye

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Renzetti, N.A., (ed.). (continued)
irritation ratings by day and by organization for the entire period are tabulated.

Data were collected for plant damage to the Pinto bean plant, oxidant 24-hr. mean and oxidant maximum from Aug.-Nov., 1954. Plant damage symptoms were typical of those induced by oxidized hydrocarbons, but not by O_3, and occurred from 79.7-87.8% of the time smog was present over the Basin. The plant injury indexes, or quantitative estimate of damage, could not be significantly correlated with either 24-hr. mean or maximum values of oxidant. The % of plants damaged, or the qualitative estimate of injury, was significantly correlated with both the 24-hr. mean and maximum values. It is concluded that the release of I_2 from KI is not measuring the plant damage factor, but rather a condition in which the phytotoxicant also occurs.

The technics used in data reduction by the Stanford Research Institute are described. The results of the measurements of the various smog constituents discussed in great detail accompanied by many graphs. The monthly average concentration ranges may be summarized as follows.

Contaminant		Monthly average concentration range*	
oxidant	(Aug.,Sept.,Oct.,Nov.)	1 - 22 pphm	(10 stations)
NO_2	" " " "	1 - 65 "	(4 stations)
hydrocarbon	" " " "	10 - 50 "	(2 " downtown L.A. Pasadena
CO	(Aug.,Sept.,Oct.)	50 - 1300 "	(2 " same
aldehydes	(Sept.,Oct.,Nov.)	1 - 29 "	(2 " "
SO_2	" " "	0.5 - 12 "	(1 station-downtown L.A.)
Particulate matter (PM)	(Aug.,Sept.,Oct.,Nov.)	0.227- 0.500mg./$m.^3$	(2 stations as above)
Pb		2.2 - 8.3 µg./$m.^3$	
organic matter		22.1 -106.0 "	
$SO_4^{=}$		7.6 - 38.9 "	
NO_3^-		7.9 - 41.5 "	
$PO_4^{\equiv}$		0.57- 1.49 "	

*values plotted by hour of the day.

Oxidant values measured from the blimp tended to increase from the surface up to the base of inversion and decrease in the inversion layer and above. N oxide values also tended to decrease above the inversion base. Transmissometer visibilities showed diurnal variation corresponding with inversion heights, more particularly in Sept. and Oct. Measurements of solar radiation showed that smog tends to reduce the radiation in downtown Los Angeles some 10%. It also appears that radiation is a limiting factor in the formation of oxidant on days with <500 langleys/day.

Significant correlations between eye irritation and simultaneous concentrations of PM, oxidant, hydrocarbons and other contaminants at a number of stations occurred. A significant correlation with a particular contaminant does not necessarily imply that eye irritation is caused by that material, since many of the contaminants follow similar patterns due to common factors and correlate well with each other. But from the large number of correlations it is reasonable to suspect a direct connection. Strikingly good correlations were obtained between plant damage at the various stations on each day, indicating that whatever factors are involved vary in a systematic manner over the network of stations. Relatively complex and diversified, significant correlations between plant damage and other variables also occurred. Visibility correlates well with concentrations of many contaminants, especially when the effect of natural fog is eliminated by choosing only days with low relative humidity. Correlations among oxidant, aldehyde, hydrocarbons and N oxides give information about reactions leading to smog formation. Oxidant concentration is found to increase with

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Renzetti, N. A., (ed.). (continued)
increasing NO_2 concentration to a maximum value and then to decrease in a manner very similar to that reported by Haagen-Smit. The ratio of aldehyde to hydrocarbon concentrations correlates well with oxidant concentration, indicating that hydrocarbon is being converted to aldehyde simultaneously with the production of oxidant. The concentration of NO_2 exhibits an inverse relationship with oxidant concentration under some circumstances, indicating consumption of NO_2 during production of oxidant. All of these observations are consistent with the postulated photochemical reactions involving hydrocarbons and NO_2 and resulting in the production of oxidant and aldehyde. The maximum oxidant concentrations and maximum values of aldehyde to hydrocarbon ratio occur at a time near the peak of the daily solar energy cycle and correlate quantitatively with integrated solar energy, again suggesting a photochemical process. Correlations confirm that concentrations of contaminants decrease as the inversion height increases, due to the larger dispersal volume available. Characteristic patterns of contamination and smog effects are found over the Los Angeles basin, in which certain stations consistently have higher values of a particular variable than do other stations. These patterns are almost identical for daily average and peak values of the variables. The weekly patterns of oxidant, visibility and plant damage for the various stations fail to show any systematic trends which can be identified with human activity. However, a striking illustration of the effect of human schedules is provided by the change from daylight to standard time, when the time of maximum oxidant concentration was found to shift by 1 hr. at the stations exposed to heavy traffic, but not at outlying stations.

201. Santa Clara County Health Department (Turner, W.E., Director): Air Pollution Report 1948-55. San Jose, Calif., Santa Clara County Health Dept., 1955, 11 pp.

Santa Clara County is at the southern end of the San Francisco bay area, and its air pollution problem is intensified by the prevailing winds which sweep pollutants into a pocket comprising most of the county, where they remain in periods of inversion. This report describes the control program which has been in effect several years, including air sampling and analysis, reduction of pollution from existing sources and review of plans for new industry. The program is being carried out with the cooperation of industry. Air analysis reveals the presence of the common pollutants, including O_3 and other oxidants (0.05 ppm-usual concentration), aldehydes (0.05 ppm), N oxides (0.02 ppm), S oxides (0.02 ppm), CO (0.2 ppm) and PM (100 µg./m.^{3}). All these are ca. 20-25% of the usual concentration found in the Los Angeles area. Other factors in air pollution are H_2S arising from the dumping of garbage into the bay and insecticides from spraying. The problem will become acute as the area is more largely industrialized, and it is hoped that control measures at this stage will prevent a repetition of the situation now existing in Los Angeles.

202. Stocks, P. and Campbell, J.M.: Lung cancer death rates among non-smokers and pipe and cigarette smokers. An evaluation in relation to air pollution by benzpyrene and other substances. Brit. Med. J. 2:923-9, 1955.

This publication is an interim report on the basis of data collected during the first 2 yrs. of an investigation carried out by the Cheshire and North Wales Branch of the British Empire Cancer Campaign. Extensive environmental histories covering the last 20 yrs. have been collected on 90% of the 10,000 patients having died of cancer, and of 12,000 patients having been hospitalized during the 2-yr. inquiry. Death rates were calculated for men belonging to any of the following 3 age groups: 45-54, 55-64 and 65-74 yrs., who had died of pulmonary or bronchial cancer. According to

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Stocks, P. et al. (continued)
their smoking habits, they were grouped into these categories: nonsmokers, pipe smokers, cigarette smokers (light - 2-99/wk., moderate - 100-249/wk. and heavy - >250/wk.). At 10 different sites representing rural (Wales), urban (Liverpool) and mixed rural-urban (Chester, Wrexham) areas, sampling stations were set up for the determination of the concentrations of 3:4-benzpyrene, 1:12-benzperylene, anthracene, pyrene and fluoranthene in the air. Measurements of the amount of atmospheric pollution were made by means of PbO_2 cylinders and by the material collected from 10 air filters dispersed throughout the region.

The rural death rate increased proportionately to the number of cigarettes smoked/wk., i.e., 1/1,000 for each 13 cigarettes/day. The standardized death rates (SDR) for pipe smokers corresponded to the of persons smoking 25 cigarettes/wk. In all smoking categories, the SDR for Liverpool exceeded that of the rural and mixed areas. The urban:rural ratio of 9:1 among nonsmokers decreased progressively in the other smoking categories to reach a small value, indicating nearly unity among the heavy smokers. In all 3 areas, the lung cancer death rates increased from nonsmokers, to pipe smokers and to cigarette smokers, and among the latter, with number smoked. The results for the urban SDR show an excess of 100 added to the death rate/100,000 of lung cancer, regardless whether smokers or not, which suggests the presence of an "urban" factor as cause of about 3/4 of the 50% lung cancer deaths attributed to cigarette smoking. The concentrations of total smoke, 3:4-benzpyrene, the other polycyclic hydrocarbons and SO_2 in the air were found to rise with increasing urbanization and population density. The following urban:rural ratios are given: total smoke - 6:1, 3:4-benzpyrene - 10:1, 1:12-benzperylene and SO_2 - 8:1, which values correspond well to the 9:1 mortality ratio of nonsmokers in this area. From the data collected, it is estimated that a "standard" man would, on certain maximum assumptions, inspire annually about 450 µg. of benzpyrene in Liverpool, 157 µg. in the mixed area and 41 µg. in the rural area. It is assumed, as a working hypothesis, that benzpyrene is the agent responsible for the association of lung cancer with both smoking and urban residence. Since this is not the final report the conclusions may eventually be modified.

203. Tuyns, A.: Le problème du cancer du poumon. (The problem of lung cancer.) Arch. belges méd. sociale, hyg., méd. du travail et méd. légale 13:392-403, 1955.

The author rejects the following factors as playing any part in the etiology of primary cancer of the lung: previous infections (nonspecific, metaplastic conditions may have some influence), physical agents (with the exception of Ra) and chemicals (with the proved exception of As, Co, Ni and chromates). He concludes that the epidemiologist has to study the conditions affecting a considerable number of individuals, e.g., automobile exhausts, soot, mineral oils, tar, asphalt, etc. which pollute the atmosphere. The frequency of the disease in Belgium is demonstrated in a graph: in communities of ≦5,000 inhabitants, it is 3.29, in those of ≦30,000, 5.25, in those of ≧30,000, 6.57 and in the largest cities, 12.29 per 100,000. A table shows the prevalence in different occupations. At the top of the list, these occupations are recorded (incidence/100,000 of the same occupational group): stone quarry workers, 58.45; construction workers, including painters, masons, etc., 19.84; transport workers, 16.03. Turning to the part played by tobacco consumption, a table is given in which the figures of Wynder and Graham, Doll and Hill and Watson and Conte are set out, showing the %'s of smokers and nonsmokers in patients with lung cancer and in controls. The % of smokers is always greater in the cancer group than in the controls. A series of personal observations on 245 cases of pulmonary

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Tuyns, A. (continued)

cancer during 1953 showed 12 (4.9%) nonsmokers; 210 (90.13%) of the 233 smokers smoked cigarettes, 117 of them at least 20 cigarettes/day. No smoking habits were recorded in the controls. Among 8 nonsmokers with pulmonary cancer, from whom histological examinations were obtained, there was only 1 epithelioma, 1 anaplastic carcinoma and 4 adenocarcinomata. Among 55 patients with bronchial epithelioma, there were 54 smokers and only 1 nonsmoker (1.82%); among 20 with anaplastic growths, there was 1 nonsmoker (5.00%) and among 14 with adenocarcinomata, 4 nonsmokers (28.57%). These findings are tabulated in order to show how closely they conform to the figures given by Wynder and Graham and Doll and Hill. The great increase in pulmonary carcinoma observed in recent years concerns mainly epitheliomata. Hence, the author argues that since exogenous factors play a more important part in the etiology of this form of cancer than in other histological types, the part played by tobacco is greater and the proportion of smokers higher, whereas the proportion of smokers among patients with adenocarcinomata is the same as in the normal population, since the influence of tobacco consumption is insignificant in this form of cancer.

204. Waller, R.E. and Lawther, P.J.: Some observations on London fog. Brit. Med. J. 2:1356-8, 1955.

Though there were no long periods of dense fog in London during the winter 1954-55, visibility was reduced to <200 yds. for a few hr. at a time on several occasions, with accompanying increases in the levels of smoke and SO_2. Such a fog occurred the night of Dec. 15/16 when H_2SO_4 was also detected in the H_2O droplets in a concentration of ca. 1 mg./m.^{3}. On Jan. 19, 1955, very wide variations in the concentration of smoke were observed, and a 10-fold increase occurred in a 2-hr. period. There was also an increase in SO_2, but no H_2SO_4 was detected by the methods used, although traces might have been present in the form of minute droplets. The maximum concentrations measured were 6.5 mg. smoke/m.^{3} and 1 ppm SO_2. Most of the smoke particles were $<1\mu$ in diameter. The records of 29 patients with an established diagnosis of chronic bronchitis and emphysema, who had been daily recording their own assessment of their state of health since Oct. 1954, showed that a temporary deterioration in their clinical condition coincided with the fog episode. It is concluded that the results emphasize that measurements of pollution over 24- or 48-hr. periods do not necessarily indicate the hazard to which the population may be exposed.

205. Albert, R.E. (ed.): Impact of the atomic energy industry on community health. Panel discussion at the Fifteenth Annual Congress on Industrial Health, Washington, D.C., Jan. 25-26, 1955. Arch. Ind. Health 13:425-67, 1956.

The following are the papers presented at the panel:

Sterner, J.H.: A review of the health problems in the atomic energy industry to date, pp. 426-7.
Davis, W.K.: Industrial power reactors and their location, pp. 428-32.
Albert, R.E.: Industrial medicine in the nuclear reactor power facility, pp. 433-4.
Western, F.: Control of radiological hazards in the operation of a nuclear reactor, pp. 435-6.
Holaday, D.A. and Terrill, J.G., Jr.: Responsibility of public health agencies in monitoring, control, and public education, pp. 437-9.
Robinson, J.C.: Accidents in a nuclear power reactor operation, p. 440.
Parker, H.M.: Effects of reactor accidents on plant and community, pp. 441-2.
Taylor, R.M.: The disaster plan and medical problems in a nuclear reactor facility, pp. 443-5.

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Albert, R.E. (ed.). (continued)

Terrill, J.G., Jr.: Power reactor accidents--role of the Public Health Service, pp.446-7.

Manov, G.G.: Health problems associated with the use of radioisotopes in industry, pp. 448-50.

Dunham, C.L.: Health problems associated with the use of radioisotopes in medicine, pp. 451-3.

Parker, H.M.: Health problems associated with the radiochemical processing industry, pp. 454-7.

Bugher, J.C.: Transition of the atomic energy industry from government to private control, pp. 458-61.

Of these papers, the one by Parker, H.M.: Effects of reactor accidents on plant and community, pertains most specifically to atmospheric pollution outside the plant, and is the only one abstracted.

206. Blifford, I.H., Jr. and Rosenstock, H.B.: Fallout dosages at Washington, D.C. Science 123:619-22, 1956.

It has been assumed that the fission product conglomerate emits 1 γ ray/ β particle throughout its lifetime. The fallout velocities are not accurately known, and in some cases the detonation and response times have been approximated. For these reasons, the dosages reported in this paper can be accurate in order of magnitude only. With these reservations, an infinity dose of 0.2 roentgen or less due to all explosions between Jan. 1951 and May 1955 is reported for Washington, D.C. Therefore, it is probable that the total fallout from all weapons tests that have so far been conducted will produce only a fraction of the lifetime dosage due to natural radioactivity and cosmic radiation. Most of the dosage comes from the Nevada tests, and only a small part (7%) from the Pacific thermonuclear tests. Fission products contained in that part of the cloud of a thermonuclear explosion which extends above the level of precipitation is found to contribute only very slightly to the dosage at great distances. No analysis was carried out for air activity data taken at other locations, but their qualitative similarity to those taken in Washington suggests that infinity doses in most other locations in the northern hemisphere will not be greatly different. Present results are in essential agreement with 2 other measurements that have been reported. Eisenbud and Harley (Science 121:677-80, 1955) have measured fallout deposited on gummed papers at various locations in the U.S. and have found an average dose of 0.001 roentgen/yr. Stewart, Crooks and Fisher (The radiological dose to persons in the U.K. due to debris from nuclear test explosions. Atomic Energy Research Establishment Harwell HP/R 1701, 1955) have measured the activity of air, rain water and ground deposits in England and report an infinity dose of 0.055 roentgen. This somewhat lower figure may result from their greater distance from Nev., which appears to be the source of most of the fallout in the U.S. (Authors' summary.)

207. Canada, Department of National Health and Welfare, Epidemiology Division: Detroit-Windsor Air Pollution Health Study, Field Methods 1953-55. Ottawa, March, 1956, 25 pp. and 21 appendices.

This report gives a complete account, including all charts and questionnaire forms, of the field methods used in the Detroit-Windsor Air Pollution Health Study 1953-55. No results are reported. The special studies included: A. Review of the incidence of sickness and respiratory ailments in Windsor high and low pollution areas, Kingsville and Harrow, 1949-1954 (material derived from data collected by the Windsor Medical Care Plan); B. Survey of chronic upper respiratory conditions among residents of Windsor, Simcoe, Kingsville and Harrow; C. Attempt to ascertain the amount of nasal

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Canada, Department of National Health and Welfare, Epidemiology Division. (continued)
preparations sold in Windsor as compared to sales of similar preparations in other Ontario industrial centers of comparable size; D. Review of Windsor high and low pollution area elementary school absenteeism records; E. Comparison of morbidity and mortality data by selected cities for selected causes and F. Individual health questionnaire. The most important study was the Air Pollution Household Morbidity Study. The organization, methods, preliminary testing and training of enumerators are discussed. See also:
Peart, A.F.W. and Josie, G.H.: Some considerations in planning a comprehensive study to determine the effects of air pollution on health. Arch. Ind. Hyg. and Occupational Med. 7:326-38, 1953, and
Peart, A.F.W., Anderson, C.P., Rabson, A. and McEwen, W.L.: Pretest of forms and field techniques for use in the Detroit-Windsor air pollution study. Arch. Ind. Health 11:47-52, 1955.

208. Cholak, J., Schafer, L.J., Yeager, D.W. and Younker, W.J.: Gaseous contaminants in the atmosphere. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 2B.
In a continuing investigation of the levels of concentration of a number of gaseous pollutants in the urban atmosphere, the findings for 3 seasons of the year are reported for a station located centrally in Cincinnati. Continuous recordings of the concentrations of oxidant along with the automatic continuous collection of integrated 2-hour samples for SO_2 were obtained to observe the diurnal and nocturnal variations in the concentration of these gases. The levels of concentration of NO_2 and CO were obtained from grab samples collected several times daily during the period from Sept. through Dec., 1955, Apr. 1956 and part of July 1956. An automatic and continuous NO_2 analyzer was placed in operation in Apr. and also used for a 30-day period starting July 2, 1956. The instrumental and analytical technics are described and the findings are compared with those reported for Los Angeles and for a period of 85 consecutive days for Washington, D.C. Relationships among the concentrations of oxidant, NO_2 and SO_2 in the atmosphere and the evidence for the photochemical production of oxidant are discussed.

209. Dechigi, M. and Paccagnella, B.: Beobachtungen und Betrachtungen zum Problem der Luftverunreinigungen im Raume Mestre-Marghera (Venezia). (Observations and considerations on the problem of air pollution in the region of Mestre-Marghera (Venice)). Arch. Hyg. u. Bakteriol. 140:44-51, 1956.
On the basis of 803 analyses of air samples, the problem of air pollution at Mestre-Marghera, near Venice, Italy, is discussed, and the average maximum concentrations of SO_2, NO_2, F and suspended matter are illustrated in 4 figures. The considerations that had to be taken into account before establishing the final over-all working plan included the experiences derived from similar investigations carried out in other countries, the geographical and metereological conditions, various financial and time factors as well as the location of the particular industrial plants under investigation. The collection of air samples was carried out mainly during the period between Apr. and Aug. at stationary sampling stations for monthly readings which are still being continued and with mobile sampling posts for a variety of readings. The instruments and methods employed are described. Frequently, the highest concentrations were detected not in the immediate vicinity of the industrial plant giving off effluents containing SO_2, NO_2 and F, but at a certain distance. It is intended to devote further studies to the problem of correlating the combined action of the various air contaminants, the temperature inversion and the smog which often prevails in

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Dechigi, M. et al. (continued)
the area during the winter months, with the development of the severe respiratory disturbances which, according to the author, occur among the population of this region and which always show a marked increase during the winter months. The figures, indicating no units of measure, as recorded on charts for the area under consideration, are of the following magnitudes: SO_2, 0.009-0.044; NO_2, 0.008-0.048; F, 0.004-0.145; suspended dust, 347-5486.

210. Dikun, P.P., Shabad, L.M. and Norkin, V.L.: (Some new data on atmospheric contamination of industrial cities with 3,4-benzopyrene.) Gigiena i Sanit. No.1:6-11, 1956.

3,4-benzopyrene can be found in appreciable quantities in the atmosphere of industrial cities on the basis of test run in various parts and environs of Leningrad. It is estimated that the industrial sections of the city may receive a fallout of 200 g./sq. km. in a period of 0.5 yr. (CA 50:8952, 1956.)

211. Eastcott, D.F.: The epidemiology of lung cancer in New Zealand. Lancet I: 37-9, 1956.

Since immigrants and persons in New Zealand, other than Maoris, are predominantly of the same British descent, it is possible to assess the relative effects of the British and New Zealand environments in the development of cancer by comparing the mortalities from that cause among them. Rates in these groups have, therefore, been calculated from the deaths for 1949-53 and the populations recorded at the 1951 census. The incidence of lung cancer is higher in the bigger towns and, since the immigrants tend to reside in the towns, it is necessary to standardize for place of residence as well as for age groups before the comparison can be made. The standardized rates show no significant difference for 9 sites, but the rates for pulmonary cancer are appreciably higher among the immigrants (30%). They are, moreover, higher among persons who immigrated after the age of 30 than among those who immigrated earlier in life (75%).

In New Zealand, the rates for deaths from lung cancer have increased continuously during the past 20 years at all ages above 35 years in both sexes (except for women in the age group 35-44 years), but they have been substantially lower than in Great Britain throughout. It is concluded that the British environment must have a special effect influencing the development of lung cancer, the intensity depending on the length of exposure to that environment. The total tobacco consumption per head has been practically the same in both countries since 1900 and this is, therefore, unlikely to be the responsible factor in the etiology of pulmonary cancer. The total tobacco consumption per head does not seem to be correlated with lung cancer mortality in a number of countries. Figures for cigarette consumption in New Zealand are not included. The evidence points to the pollution of the atmosphere which is associated with urbanization, as had been suggested in other studies. It shows, too, that these factors may exert their carcinogenic effect a long time after the persons have left the exposure, and this is in keeping with what is known of the mode of action of the carcinogens isolated from the atmosphere of industrial cities.

212. Eisenbud, M.: The AEC fallout monitoring network. J. Air Pollution Control Assoc. 6:144-7, 1956.

The U.S. Atomic Energy Commission has set up a network of monitoring stations, covering the entire country, which is comprised of 89 stations when tests are being conducted in Nev. and of 41 at other times. The basic mechanics of fallout are reviewed. Radioactive decay samples are collected by contact on a 1-ft. gummed acetate film supported horizontally ca. 3 ft.

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Eisenbud, M. (continued)
above ground, and analyzed by ashing and measuring activity in a β-counter. Limitations in methods of collection are discussed. The cumulative fallout data in the U.S. between 1951 and Aug. 1955, and extrapolated to Jan. 1, 1956, are given by states, Nev. excepted. It varies from 22 mc./sq.mi. in Calif. to 260 in Colo. The higher values, reflecting the path of fallout, in general, occur in the states E and SE of Nev. The cumulative data are characterized by marked uniformity, for although there is >10-fold difference between the high and the low values reported, the spread of the values within large areas of the country is relatively narrow. The isotope Sr^{90}, which is present in fallout, is of great biological significance. Analysis of samples of soil from various parts of the country discloses the Sr^{90} content of the total fallout radioactivity to range from 1-5% which is ca. 1 mc./sq.mi. or 1/1000 the amount of Ra normally present in the upper foot of soil.

213. Eisenbud, M. and Harley, J.H.: Radioactive fallout through September 1955. Science 124:251-5, 1956.

This report summarizes the data on radioactive fallout collected in the U.S. and abroad by 88 stations, including 26 in the U.S. The information will serve to estimate the levels of human exposure caused by nuclear detonations at various distances and includes data on mixed fission products, Sr^{90} and cumulative γ dose. Sampling was carried out with adhesive-coated films which were mailed each day to the U.S. Atomic Energy Commission Health and Safety Laboratory in New York, in order to be assayed, the results being corrected by a factor of 1.6 to conform in accuracy with those obtained by use of high-walled pot collection. Systematic collecting was begun in the U.S. in 1951 and at the stations abroad at various other times, but it was carried out at all stations since Jan. 1, 1954. The values reported for mixed fission products and for Sr^{90} are given as mc./mi.^{2} and in millirads (mrads) for the cumulative γ dose (estimated dose for infinite time delivered to populations who are exposed from the start of the sampling period). The following ranges are taken from the detailed recorded data: mixed fission products: 740 (Grand Junction, Colo.) to 33 (Lagos, Nigeria); Sr^{90}: 24 (Iwo Jima) to 1.8 (Peru) for the values obtained at the stations abroad, 23 (Salt Lake City) to 2.1 (San Francisco) for the U.S. stations; γ dose: 49 (Memphis, Tenn.) to 5.8 (San Francisco), with 3 exceptions: 110 (Albuquerque), 120 (Grand Junction) and 160 (Salt Lake City). The values for γ dose from the stations abroad ranged from 23 (Colombo, Ceylon) to 3.6 (Thule, Greenland), with the exception of the results from some Pacific Island, which ranged from 150 to 13.

The total accumulated values for mixed fission products are important only in so far as they serve as a basis for estimating the γ dose delivered and the amount of Sr^{90} present. In the discussion of the significance of the calculated exposures, which cover the period of the past 4 yrs., the following values are mentioned for comparison: the average γ dose/capita may be taken in the order of 10 mrads, as compared with the average external dose from natural sources which is estimated to be 300 mrads. As to Sr^{90}, the 4-yr. exposure/person is calculated as 10^{-4} μc., as compared with 0.1 μc., established as the maximum permissible dose.

Another method of evaluating the significance of Sr^{90} fallout is to measure the presence of this isotope in soils, plants, animals, human foodstuffs, etc. Radiochemical technics are sufficiently sensitive for this purpose. Since the concentration of the Sr^{90} in the foods is dependent on the Ca content, the results can be expressed best as Sr^{90} activity/g.Ca. U.S. milk in early 1956 was found to contain 3 μμc. of the isotope/g.Ca, ^{1}/350 of the amount accepted as permissible as content for the adult skeleton.

214. Falk, H.L., Markul, I. and Kotin, P.: Aromatic hydrocarbons. IV. Their fate following admission into the atmosphere and experimental exposure to washed air and synthetic smog. Arch. Ind. Health 13:13-7, 1956.

It has been shown that the aromatic polycyclic hydrocarbons vary in their stability in the atmosphere, with 3:4-benzpyrene belonging to the group with maximum relative stability. The destruction of aromatic polycyclic hydrocarbons in the atmosphere indicates that their stability is consistent with survival in the atmosphere for sufficient periods to be respired by exposed populations. Even in the presence of a strong oxidizing atmosphere, such as occurs in characteristic Los Angeles smog, the rate of destruction of 3:4-benzpyrene is lower than that of many other hydrocarbons. In other areas where this atmospheric property is less significant, the stability should be markedly greater.

It is concluded that there is a varying effect of the atmosphere on the survival of individual aromatic polycyclic hydrocarbons, including 3:4-benzpyrene. Investigators studying the C and aromatic polycyclic hydrocarbon content of human lungs should be aware of the differences in the stability properties of these compounds.

Variations in the stability of this group of compounds limit the use of any one as an accurate index of over-all atmospheric polycyclic hydrocarbon pollution. Significant differences in stability in the light and the dark have been demonstrated for certain compounds. Differences in the destruction rate of aromatic polycyclic hydrocarbons in their pure, unadsorbed state and while adsorbed on soot must be attributed to the modifying effect on the hydrocarbons of the soot particles acting as carrier.

215. Greenburg, L. and Jacobs, M.B.: Sulfur dioxide in New York City atmosphere. Ind. Eng. Chem. 48:1517-21, 1956.

For the past 2 yrs., the Department of Air Pollution Control of N.Y. City has sampled the atmosphere for SO_2 and noted the seasonal and daily variations in its concentration. The equivalent of nearly 32,000,000 tons of coal is burned in N.Y. City yearly for heat, light, power and hot water. Figuring that these fuels contain an average of 2.5% S, it is estimated that >1,500,000 tons SO_2 are given off to the atmosphere yearly and from this a possible 2,200,000 tons of H_2SO_4 may be formed. Other minor sources of SO_2 are motor exhausts, domestic incinerators and trash fires. Studies of the seasonal variations show a high in Dec. and Jan. when the average concentration is ca. 0.25ppm, and a low in June and July when the average is <0.10 ppm. Maximum concentration in winter reaches 0.8 ppm. Diurnal variations were also noted. A maximum usually occurs during the morning hrs. from 6:00-10:00 a.m.; concentration then diminishes until ca. 2:00 p.m.; it increases in the late afternoon or early evening and then decreases again until ca. 2:00 a.m. This variation is comparable to the daily trend in fuel consumption. Higher SO_2 concentrations are obtained when a temperature inversion occurs. At $\geq$ 500 ft. temperature inversion, SO_2 concentration has ranged from 0.56-0.80 ppm. At <500 ft., the concentration has ranged from 0.31-0.43 ppm. At $\geq$1200 ft., SO_2 concentrations are lowest, i.e., from 0.17-0.24 ppm. When there is no inversion, the concentration is 0.01-0.07 ppm. In general, the SO_2 concentration falls off with distance from Manhattan, except in more densely populated areas of the city, e.g., downtown Queens or Brooklyn, where there is relatively little variation in SO_2 concentration. On 2 occasions, there was an abnormal geographical distribution of SO_2.

216. Haenszel, W., Marcus, S.C. and Zimmerer, E.G.: Cancer Morbidity in Urban and Rural Iowa. Public Health Monograph No. 37, (U.S. Public Health Service Publication No. 462.), 1956, 85 pp.

This study of cancer morbidity in Iowa was the first attempt to collect

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Haenszel, W. et al. (continued)

morbidity data for both the urban and rural populations of the State, previous morbidity surveys having been confined to metropolitan centers. The survey was undertaken to answer such questions as: how many people have cancer, and what differences are there between urban and rural populations. Mortality data do not provide complete answers to questions of this type and morbidity data collected from an individual hospital or clinic have a limited usefulness, since they cannot be related to a defined population group. For the present study reports were obtained on a questionnaire (reproduced in an appendix) on all cancer patients treated or observed by hospitals, clinics and physicians in the entire State (population >$2^1/2$ millions) during 1950, with personal visits to those who did not reply. Reports were obtained from 99% of the hospitals and clinics and from 88% of the physicians. Data on deaths from cancer were obtained from the death certificates for 1950. There were 14,834 residents in the State of Iowa under medical supervision for cancer during 1950, of whom 8,198 were first diagnosed during that year. Of the newly diagnosed cases, 78% were reported by hospitals, 81% in urban areas and 73% in rural areas. Microscopic confirmation was obtained in 75.5% for all sites, varying from 95.2% for corpus uteri down to 33.3% for liver; 82.1% of the cases reported by physicians were microscopically confirmed. The cancer illness rates /100,000 observed in Iowa for 1950 were: incidence 301, prevalence 442, mortality 129, after adjustment for age composition of the population. The age-adjustment urban incidence rate for all sites (350) was 37% > its rural counterpart (255). The highest rates/100,000 for males were prostate 35.8, stomach 24.7, large intestine 21.0 and lung 18.8; for females, the highest rates were breast 70.3, cervix uteri 33.4 and large intestine 25.9. Incidence rates were higher in the urban than in the rural population for lung (males 29.0/10.2), larynx and cervix, and these differences appear to be real; similar findings from mortality data elsewhere for cancer of the lung are well known and have provided part of the evidence for the atmospheric pollution theory of carcinogenesis, but the sex differences in both mortality and incidence make it necessary to postulate either special exposure for males or sex differences in response. For cancer of the prostate, the urban/rural agreement was very close, supporting the view that the frequency of this cancer is not influenced by environmental factors; on the other hand, there was a much higher urban incidence of cancer of the bladder, especially in females, than could be accounted for by exposure to industrial chemicals. The age and sex patterns of cancer incidence in Iowa conformed generally to those reported in morbidity surveys elsewhere, higher rates prevailing for females from 10-60 yrs. of age owing to the relatively large numbers of malignant tumors of the breast and genital organs, whereas in the male, the rate rose steeply after 60 yrs. of age, principally owing to the high rate for cancer of the prostate. Useful tabulations give the 5 leading cancer sites in each age group by sex and the percentage distribution of newly diagnosed cases by primary site and age. Carcinoma constituted 86% of microscopically confirmed cases; adenocarcinoma was more frequent among females and epidermoid carcinoma among males; leukemia was the most frequent histological type at ages <15. Excluding cancer of the hemopoietic and lymphatic tissues, the growth was confined to the original anatomical site in 67%, had spread to adjacent tissues or regional lymph nodes in 24% and had metastasized to remote tissues in 9% at the time of diagnosis. In males 71% were diagnosed while still localized, but in females only 63% owing to the preponderance of breast cancer, for which the probability of early diagnosis has been relatively poor. The proportion of localized growths was higher in the accessible sites--only 49% of cancers involving the digestive system were diagnosed while clinically localized, compared

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Haenszel, W. et al. (continued)
with 86% for the buccal cavity. Of patients with cancer diagnosed while localized 81% survived 12 mo., contrasted with 45% of those with regional involvement and 27% with remote metastases. The uterus and large intestine are among the sites showing the greatest range in survival rates for patients in early and late stages. The average stay of patients in hospital was 23 days, 20 days for 1st admissions. There are 27 tables and 16 figures in the text, and 8 tables in the appendix. (Abst. Bull. Hyg. 31: 1105-6, 1956.)

217. Hirschler, D.A., Gilbert, L.F., Lamb, F.W. and Niebylski, L.M.: Particulate lead compounds in automobile exhaust gas. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 15Q.

A comprehensive study has been made of the amount, composition and particle size distribution of the Pb compounds present in the exhaust gases of automobile engines operated on fuels containing tetraethyllead. The results show that city-type driving tends to exhaust considerably less Pb than is burned by the car and that the excess Pb which deposits on exhaust systems surfaces tends to be exhausted under higher-speed or higher-load operating conditions. The exhausted material ranges in particle diameter from 0.01μ to several mm. and is composed mainly of $PbCl \cdot Br$, α and β forms of $NH_4Cl \cdot 2PbCl \cdot Br$ and $2NH_4Cl \cdot PbCl \cdot Br$. The data provide an explanation for the low Pb concentrations which have been reported for urban atmospheres in relation to the consumption of leaded gasolines. (Authors' abstract.)

218. Joules, H.: The epidemiology of lung cancer in New Zealand. Lancet I:163, 1956.

This letter to the editor is written as a reply to a paper by D.F. Eastcott, published under the same title in Lancet I:37-9, 1956. (See abstracts Eastcott and also Torrance, Ibid., 286-7.) The author claims that in the paper referred to, the significant scientific evidence of a relationship between cigarette smoking and the incidence of lung cancer (no references given) has been neglected. He states that until 1925, England led the world in the number of cigarettes smoked per head of population. There was a 100% increase in cigarette consumption in the period 1910-25, and statistics show that during the past 5 years, most deaths from bronchial cancer occurred in men who had begun to smoke during that time, especially during the 1914-18 war. A comparison of the incidence of lung cancer with that in other sites reveals a steady rise of epidemic extent not explained by changes in urbanization. The author attributes the situation to the vast over-all rise in cigarette consumption and recommends constant information of the public of the risks involved in cigarette smoking.

219. Klevin, P.B., Weinstein, M.S. and Harris, W.B.: Ground level contamination from stack effluents. Am. Ind. Hyg. Assoc. Quart. 17:189-92, 1956.

Soil sample surveys were conducted at 3 AEC facilities to determine the concentration gradients of U in the soil with respect to depth, distance and direction from the source of pollution. These plants have been in operation for over 14 yrs. and have discharged 18.5, 50 and 52 tons, respectively, of U as metal in the stack effluents. About 40% by weight of the effluent was estimated to be still in the ground at the 2 plants A and B where the discharge was largely insoluble material. The soluble salts, mostly from the plant C, remained only to the extent of about 1.2%. The maximum average concentration of U was about 50 μg./g. at the 500 ft. radius. There was no significant effect of direction from the source [illegible]ius Effect). The soil concentration in each case decreased linearly

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Klevin, P.B. et al. (continued)
with distance and was within the range of normal background of U in soil (3-9 μg./g.) beyond about 2000 ft. from the center of plant activities. Plants A and B showed a soil concentration decrease approximately as the square of the distance from the source. Plant C showed a much flatter decrease. The top inch of soil contained about 2-3 times the concentration of the lower 5" where the material was insoluble, while no difference was found where the effluent was in the form of soluble salts.

✓ 220. Kotin, P. and Falk, H.: The deposition of carcinogen-bearing particulate matter in the tracheobronchial tree in relation to particle size and effect of air pollutants and tobacco smoke on ciliary activity and mucus secretion of the respiratory epithelium. Proc. Am. Assoc. Cancer Research 2, No.2: 127-8, 1956.

A review of squamous metaplasia and intraepithelial cancer sites in lungs obtained at necropsies suggests that mechanical factors, including that of particle deposition, may be of significance in the pathogenesis of these lesions and ultimate invasive metaplasia. A study undertaken to determine the deposition pattern of respired particulate matter (soot) in the tracheobronchial tree revealed that epithelial deposition was related both to particle size and to factors affecting the physiological activity of the bronchial epithelium. Ciliary activity and mucus secretion normally preclude the piling of particles on the epithelium. Soot particles measuring from 0.5-3.0 μ precipitate on the epithelium in relation to their size. Studies to determine the deposition site of soot particles on the epithelium, their residence time, chemical alteration in the particle and epithelial changes following localization were pursued in rats and rabbits. The residence period is normally so short that histologic demonstration of the particles is impossible. The respiration of these particles subsequent to or simultaneous with irritants as occur in urban polluted atmosphere and probably in tobacco smoke permits localization and accumulation with subsequent histologic demonstration. Measurement of movement of particles of known size was undertaken in exteriorized respiratory epithelium of intact hosts under both normal conditions and following exposure to air pollutants and tobacco smoke. These agents interfered with particle movement, permitting accumulation on the epithelium by mechanisms to be discussed. Adsorbed carcinogenic materials disappear from soot following epithelial settling. The relation of these events to human pulmonary carcinogenesis will be discussed. (Authors' abstract.)

✓ 221. Logan, W.P.D.: Mortality from fog in London, January, 1956. Brit. Med. J. 1:722-5, 1956.

A thick fog occurred in London from Jan. 4-6, 1956 which caused an estimated 1000 deaths in the Greater London area between Jan. 4 and 14. An excess of 422-454 deaths occurred in the London Administration County alone. This was estimated in 3 ways: 1) by comparing the average number of deaths/day from Dec. 25 - Jan. 3, i.e., 131, with that number after Jan. 3; 2) by comparing the number of deaths registered in weeks ending Jan. 7 and 14 with weeks ending Dec. 24 and 31 and 3) by comparing the deaths in the 1st 2 weeks of 1956 with those in the years 1948-54 (excluding the "flu" years of 1951 and 1953). The number of deaths occurring in the Greater London area was estimated at 974-982 by the latter 2 methods. Reduction in temperature at this time was not severe and could not have caused additional mortality. In the London Admininstration County the increase was relatively greatest (69%) in newborn children, but greatest in number among the elderly - 358 out of 454. Bronchitis was the principal cause of death, and the number of deaths from it increased from 169-377 between the last 2 weeks of

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Logan, W.P.D. (continued)
Dec. and the 1st 2 of Jan. Two boroughs had reduced mortality, 1 remained the same, but all the rest had increased mortality, especially in Hampstead (87%), Chelsea (86%), Westminster (84%) and Deptford (80%). In general, the largest increase took place in the western (39%) and southern (41%) boroughs and least in the southeastern boroughs (17%). The mortality increase in towns in the Outer Ring of Greater London was greatest in the northeastern and western sectors and least in the southeastern sector. The increase in deaths in the Great Towns of England and Wales outside of London was only 8%, i.e., from 8,443-9,141. Claims for sickness benefits were 24,800 more during the weeks ended Jan. 10 and 17 than during the previous 2 weeks in London and Middlesex; this was a relative increase of 72%. In the rest of England and Wales there was a 41% increase. This is the 3rd major fog mortality incident in London since 1948, it is pointed out.

222. National Research Council: The Biological Effects of Atomic Radiation. A Report to the Public. Washington, 1956, 40 pp.

This report summarizes the findings to date of investigations carried out by a group of scientists who were appointed in 1955 by Detlev W. Bronk, President of the National Academy of Sciences, to study the biological effects of atomic radiation. It is intended for the lay reader, and it extracts from the detailed reports, published at the same time, aspects of general interest. (See next abstract.)

223. National Research Council: The Biological Effects of Atomic Radiation. Summary Reports. Washington, 1956, 108 pp.

These reports, released on June 12, 1956, summarize the results of investigations conducted by over 100 scientists appointed by Detlev W. Bronk, President of the National Academy of Sciences and under the sponsorship of the Ford Foundation. The 6 committees carrying out a continuing study of the biological effects of atomic radiation were assigned to the following fields: genetics, pathology, agriculture and food supplies, meteorology, oceanography and fisheries as well as disposal and dispersal of radioactive waste. With regard to exposure, it is stated that the accumulated waste products of a fully developed, world-wide atomic power industry would exceed that which would be released in any atomic war. At present, the U.S. population is exposed to the following amounts of radiation, given as 30-yr. dose to the gonads/average person: 1) from the natural backgound - about 4.3 r. (roentgens), 2) from X-rays and fluoroscopy - about 3 r., and from fallouts due to weapon tests - 0.25 r. at the rate of the past 5 yrs., or 0.5 r. at the rate of the 2 most active yrs. As to the effects of exposure, the principal action of radiation on the cell is discussed. The reproductive organs are most sensitive to atomic radiation, and exposure might result in mutations. It has not yet been demonstrated that exposure to low doses may cause shortening of life, but there is evidence of general, diffuse radiation effects from increased exposure. Thus, the average age at death of nonexposed physicians is given as 65.7 yrs., as compared to 60.5 yrs. for radiologists. Single doses of >800 r. may result in acute blood and intestinal disorders or in delayed effects like leukemia or cancer. Other effects mentioned are: ulcers, loss of hair or temporary-in most cases - skin conditions.

So far, there is no effective method of radiation waste disposal. The numerous recommendations are based on the conclusion that the average exposure of the population's reproductive cells should not exceed:
a) 10 r. above the natural background radiation from conception to age 30,
b) a total accumulated dose of 50 r. up to age 30 and of not >50 r. additionally up to age 40.

224. Parker, A.: Purification of waste gas in the production of energy. Air pollution in Great Britain from the treatment and use of fuels. Trans. 5th World Power Conf., Vienna, 1956, Div. 3, Sect. M, Paper 9M/1, 23 pp. (Preprint.)

In some parts of the thickly populated industrial areas the amount of deposited solid matter is equivalent to between 500 and 200 tons/sq.mi./yr.; in rural areas and small country towns it is equivalent to 10-100 tons. More than half of this pollution by grit and dust is from the treatment and use of fuels. Air pollution by smoke ranges from <1 mg./100 m.^{3} in country districts in summer to >100 mg./100 m.^{3} in thickly populated industrial towns in winter. In the air of towns, at or near ground level, the concentration of SO_2 in winter is usually in the range 5-100 mg./100m.^{3}. The concentration of CO is usually well below 1 ppm by volume, but in areas of dense motor traffic it often reaches 50 ppm under normal meteorological conditions. At times of dense fog, the concentrations of smoke, SO_2 and CO in town air can rise to several times their normal value. (CA 50:13406, 1956.)

225. Parker, H.M.: Effects of reactor accidents on plant and community. Arch. Ind. Health 13:441-2, 1956.

The possibility of a violent eruption of a nuclear reactor is considered. The degree of such a disaster would depend on the following factors: the power levels of the reactor, the fraction of the active material that can escape in the event of disaster, the precise mechanism of escape of these offensive products, the population density around the reactor and the meteorological conditions, particularly at the time of the incident and in the few hours following. An arbitrary standard reactor of 100,000 kw. heat power and ca. 25,000-30,000 kw. of available electrical power is postulated. The release of fission products could occur by a conventional type of steam explosion. The energy release might either be abrupt, causing a mushroom cloud rising to the height of the order of 4000 ft., or it might be slow, in which case the reactor structure would heat up and the fission products be vaporized. The cloud would then pass downwind. Persons in the area of the cloud path would be exposed to the penetrating γ-rays, to β-rays on the skin and in the lungs and to ingestion of the fission products. These fission products are more dangerous than from an atomic bomb because they are longer-lived. From Sr^{90} 150,000 c. are accumulated in 500 days. Concentrations of radioactive particles/ft.^{2} would settle over 30-40 mi.^{2}, >2 mc./ft.^{2} over 100-200 m.^{2} and >0.5 mc./ft.^{2} over 300-500 mi.^{2}. A 5 mc./ft.^{2} in an area stands for "must control" for 5 yr., at the end of which the radiation will be down to normal background radiation. Evacuation of the area in the path of the cloud and washing of contaminated objects or coating to seal in fission products are possible methods of defense.

226. Parkhurst, E.: Differential mortality in New York State, exclusive of New York City, by sex, age, and cause of death, according to degree of urbanization. Am. J. Public Health 46:959-65, 1956.

This study is based upon the deaths recorded in the 3-yr. period 1949-51, allocated to place of residence and population figures of the 1950 census, the total rates having been adjusted to the standard population of New York State in 1940. Regional distribution (exclusive of New York City) was as follows: metropolitan areas (1 or more cities of >50,000 population), with central cities (1 1/2 million population, "urban" (incorporated places of >10,000 population) and "rural" (places of <10,000 population) within them; nonmetropolitan areas, with "urban" and "rural" districts. The total death rate was highest in the central cities; total rates for both urban and rural areas outside these cities were higher in the nonmetropolitan areas than in metropolitan ones. The mortality in the cities was lower in young age groups.

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Parkhurst, E. (continued)
In nonmetropolitan, rural areas, accidents caused a high % of deaths in the age groups 5-24 yr. The mortality experience of the adult population, however, is far less favorable in the cities than in the rural areas and more so in the metropolitan central cities than in the nonmetropolitan cities. The metropolitan rural, enjoying many of the advantages of both city and rural life, and a relatively high standard of living, has the lowest total death rate among the several sectors of the population. By middle age, however, these advantages are offset by negative factors related in some way to the urban aspects of suburban living.

227. Phair, J.J. and Thomson, M.L.: Measuring reactions to air pollution. Public Health Repts. (U.S.) 71:87-93, 1956.
The methods and plan of a pilot study to obtain definitive data on the effects of air pollution on the health of selected cardiac and respiratory patients in their homes are described. The various aspects of an epidemiological approach are discussed. In order to determine the feasibility of a morbidity survey, a field team, working under the close supervision of a competent advisory committee, was formed to conduct appropriate trials and test procedures and to appraise possible indexes. Persons unusually susceptible to variations in air pollution, e.g., the newly born and those with chronic cardiac or respiratory diseases, seemed the most likely people to observe. Further, the advantage of these people being confined to 1 locale would simplify the assessment of the amount of air pollution to which the observed individual would be exposed. In the pilot study in Cincinnati 28 persons with obviously diminished respiratory reserve, as indicated by breathlessness, were chosen and any variations in their well-being were assessed subjectively by diaries and questionnaires and objectively by instrumental methods during Jan. through Apr. 1955. The instrumental methods included time vital capacity measurement, oximeter test of blood oxygenation and the maximum inspiratory and expiratory pressure test. The pollution to which these test subjects were exposed at this time was measured by soiling of filter paper; temperature and humidity were also measured at each home and SO_2 at 4 carefully selected locations. The statistical analysis being used to evaluate the data is described. It is too early as yet to report any definite results or conclusions. It is recommended that a determined effort should be made to obtain or develop simpler and more sensitive and objective methods for the assessment of respiratory efficiency for field use. Quantitative, objective methods of measuring eye irritation and a SO_2 sampler that is quieter and that needs less servicing should also be developed.

228. Phair, J.J., Thomson, M.L., Carey, G.C.R. and Turner, M.E., Jr.: Air pollution and human reactions. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 9B.
The need for definitive clinical investigations of many problems of community air pollution has been generally recognized. For the health worker and the physician, they rank among the most important challenges remaining in the field of public health. The community and industry require guidelines for the formulation of safe and practical control procedures. Furthermore, it is essential that these be based in part upon the effect of air pollutants on man. Studies have been under way in Cincinnati for the past 4 years. Their object has been to determine the best approach to such problems under the conditions usually found in our urban communities. Two pilot studies have been completed, and a third will be undertaken this fall. The first two field investigations have attempted to record human reactions, objective and subjective, and to relate their occurrence with

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Phair, J.J. et al. (continued)
variations in the amount of air pollution as represented by the concentration of smoke. The third will add estimations of the SO_2 levels. The new features of these studies are:

1. Selection of patients with low cardiorespiratory reserves for subjects.
2. Measurement of the pollution in the immediate environment of the subject rather than utilizing neighborhood stations.
3. Use of tests of respiratory function in the home as a means of obtaining an objective estimation of patient reaction.

This report described the methods employed for the selection and follow-up of the patients, the measurement of the air pollution in the home and the very preliminary analyses of the observations. The latter aspect is complex and is considered as experimental as the approach to the field measurements.

229. Purdom, P.W.: The Administration of Air Pollution Control Programs in the United States. Paper presented at the Annual Meeting of the Conference of Municipal Public Health Engineers, Atlantic City, N.J., Nov. 14, 1956, 95 pp. (Mimeographed.)

This paper analyzes results obtained from a survey of air pollution control agencies. The purpose was to ascertain administrative characteristics of existing organizations. A questionnaire was sent to 144 air pollution control agencies. Of the 93 (65%) who responded, 82 claimed active programs. The populations served ranged from 10,000-8,000,000. Smoke was named the major pollutant the most frequently, with odors being cited a substantial number of times. Open burning was most frequently cited as the major source of air pollution problems; metal smelting and refining, internal combustion engines, unspecified chemical and industrial plants, lumber industries, petro chemical operations and incinerators were also frequently mentioned. Laws regulating air pollution and standards for compliance were usually adopted locally. Air pollution control programs were most frequently attached to health departments, but 50% attained independent agency status in the largest jurisdictions. Budget data, obtained from only 56% of the agencies, showed that expenditures varied from $0.01-$0.53/capita, with a median of $0.08. No correlation appeared between population served and per capita expenditures. Salaries and qualifications of the personnel are also analyzed. Most agencies reported that detection and determination of air pollution violations resulted mainly from visual and olfactory observations frequently supplemented by simple test equipment, e.g., a smokescope. 1/3 of the agencies reported no laboratory services available; the 2nd 1/3 reported use of state laboratories or commercial or institutional laboratories and the last 1/3 had their own. Only 1/10 of the agencies reported any type of continuing citizen or industrial advisory mechanism.

230. Rossano, A.T., Jr.: The joint city, county, state and federal study of air pollution in Louisville. J. Air Pollution Control Assoc. 6:176-81, 1956.

With the advent of World War II, an extensive synthetic rubber industry has built up in a section of Louisville, called Rubbertown. Much discomfort from odors, dust and eye irritation has concurrently been noted and attributed to this industry. The geographic, topographic and climatologic factors operating in Louisville are described and a history of what has been done in the study and control of air pollution there is given. The most recent survey of the problem, begun on Jan. 2, 1956, is described. In this survey, 4 agencies, viz., the Air Pollution Control District of Jefferson County, the Louisville and Jefferson County Board of Health, the Ky. Dept. of Health and the Community Air Pollution Program of the Public Health Service, cooperated. The 2 broad objectives were

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Rossano, A.T., Jr. (continued)
the determination of the quality of the air in and around the West End and the study of the interrelationship between air quality and both meteorologic and micrometeorologic factors. Both the air sampling and meteorologic networks are described. An inventory of air pollution sources in Rubbertown and a study of the nature and sources of objectionable odors were also undertaken. None of the results are reported, however.

231. Satterlee, H.S.: The problem of arsenic in American cigarette tobacco. New England J. Med. 254:1149-54, 1956.

Analytical data presented show that the As content of various popular brands of American tobacco cigarettes averaged 12.6 μg./cigarette, as sold in 1932-33, and has increased to ≧42 μg./cigarette in 1950-51, an increase of 300% in 20 yrs.; this increase is attributed to the use of arsenical pesticides on American tobacco plantations. Statistics show that cigarette smoking, as indicated by production and sales, increased >300% in the same 20 yrs., and the death rate from lung cancer in the U.S. rose 200% in women and 600% in men during a 20-yr. period ending in 1954.

The relation of As-containing smoke to carcinogenesis, to As metabolism and to increasing As in atmospheric environments is discussed. Though the skin is considered the chief pathway of As excretion and site of arsenical cancer, other less well known channels of As excretion are important sites of cancer. Increases in circulating As are regarded as natural to all types of rapid cellular proliferation in the organism, e.g., a hyperplasia of the uterine mucosa. The concentration of As is greatest in organs having most active cellular metabolism, e.g., the lungs, thymus, gonads, thyroid gland and crystalline lens. Most significant was the finding that excessive As is periodically discharged from the bloodstream of nonpregnant young women via the uterine mucosa and cervix uteri in the remarkably high concentration of 320 μg./100 ml., the average found in fresh menstrual blood. In 13 cases of uterine cancer, an average of 6332 μg. As/100ml. was found in biopsied tumor tissues as compared to the patients' mean blood concentration of 248 μg. As/100 ml. Analysis, by the author and a coworker, of venous blood from 51 city dwellers revealed a "volatile" As fraction averaging 40.57%, but ranging 0-100%, of the total blood As. Also an unidentified arsenical metabolite, assumed to be $As(CH_3)_3$, was isolated from the respiratory gases of these subjects. These 2 As metabolites are considered a physiological index of the detoxifying efficiency of the liver, for more As occurs in the total blood than in venous blood or exhaled air in unfavorable states of As retention, and the opposite is true in vigorous states of health. "When the pulmonary excretion of As, especially among city dwellers, is considered, it seems possible that excessive inhalation of arsenical cigarette smoke, aggravated by arsenical pollution of urban atmospheres, serves to obstruct or render stagnant the bronchial current of As excretion and so favors induction of bronchogenic cancer in cigarette smokers; presumably, this might occur more frequently in men, who lack the safety valve of a menstrual outlet." Smoke-borne As is widely prevalent not only from cigarette smoke but also in more attenuated dosage from smoke and fumes from carbonaceous-fuel combustions that pollute urban atmospheres and from air-borne As detritus from the abrasion of synthetic-rubber tires and tarred or oiled roads. An analytical survey of sedimentary house dusts in 38 N.Y. City domiciles showed an As content of 12-140 ppm with an average of 37.8 ppm. Assays of suspended particles in the same city neighborhood at 30-90 ft. above ground gave the following average weight-for-weight As concentrations: 293 ppm for sizes >30.0-0.75 μ; 660 for 0.7-0.5 μ and 2684 for 0.05-<0.25 μ. Analysis of the air particles in rural New Hampshire at 12 ft. above

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Satterlee, H.S. (continued)
ground (and 1000 ft. alt.) during the peak of ragweed pollination and flying-insect activity showed similar size and As content as in N.Y., but the gross weight was only $^{1}/12$ of the values obtained for the city filtrations. The proportion of weight of As to weight of the material was, therefore, 13% higher in the country than in the city.

It is emphasized that strict precautions are needed to avoid volatile-loss errors in assays of air suspended particles. An improved method is recommended for indoor collection and immediate acid extraction of small volumes of air when microdeterminations of "background As" in any situation are made. The importance of seeking better knowledge of As metabolism in relation to carcinogenesis, by more searching and precise methods of chemical and physical investigation, is also stressed. Special technics for employing radioarsenic are regarded as promising implementation for clarifying the problem of air-borne As and smoke-borne As in relation to lung cancer occurring in cigarette smokers and in others who live in air-polluted industrial cities.

232. Tabor, E.C., Hauser, T.R. and Burttschell, R.H.: Characteristics of the organic particulate matter in the atmosphere of certain American cities. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 4B.

A substantial portion of particulate air pollutants has been found to be organic. This study was initiated to obtain more information as to the nature of this organic material. Soluble organic materials were extracted from atmospheric particulate matter collected on glass fiber filters at sampling stations in 20 cities of the National Air Sampling Network. These organic materials were separated by standard chemical procedures into the following fractions: H_2O-soluble, H_2O-ether-insoluble, basic, weak acid or phenolic, strong acid and neutral. The neutral group was further subdivided into aliphatic and aromatic hydrocarbons and oxygenated compounds by chromatography on fractions in most instances. Distribution and characteristics of the various groups of organic materials are discussed with reference to the various sources.

233. del Vecchio, V., D'Arca, S. and Talenti, M.: (Carbon monoxide intoxication and carbon monoxide in the atmosphere in Rome.) Nuovi Ann. d'Igiene e Microbiol. 7:81-102, 1956.

The 1st part of this article discusses the origin of CO contamination of the atmosphere of towns, the pathogenesis of CO poisoning, the relation between symptoms and concentration of carboxyhemoglobin (COHb) and the atmospheric concentrations estimated by investigators in various cities of the world. The chief source of CO in urban surroundings is the presence of escape gases from motor vehicles, estimated in proportions varying from 3-14%, depending on the nature of the fuel, the cylinder performance, traffic congestion, confined spaces, etc. The affinity of CO for hemoglobin is 210 times greater than that of O_2, so that only small amounts of CO are necessary to immobilize significant amounts of hemoglobin with resulting decrease of O_2 transport by red blood corpuscles, leading to anoxemia and asphyxia. CO also binds respiratory ferments, interfering seriously with the oxidation-reduction mechanism, thus adding to its asphyxiant action the inhibition of respiratory tissue activation. Its toxic action is related essentially to the concentration of COHb. A table is given showing the correlation between the concentration of CO and O_2 in inspired air, the duration of exposure and the condition of pulmonary ventilation. Thus, for example, if a man with pulmonary ventilation of 9.5 l./min. is exposed for 2 hrs. to 0.03% CO, the % of COHb in the blood

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del Vecchio, V. et al. (continued)
reaches 15.6; in 3 hrs. it reaches 20. The coefficient of intoxication COHb/Hb indicates the % of Hb effectively transformed into COHb. In man, the lethal index is 0.66, i.e., death takes place when 2/3 of Hb is fixed. In a normal person at rest, 10% of COHb causes no symptoms, 20% slight headache, 32% headache, irritability and vertigo, 50% mental confusion and syncope, 66% unconsciousness and death, if prolonged. The normal time for elimination of CO from COHb is ca. 4 hrs.; if O_2 is substituted for air, this is reduced to 40 min.; a further reduction of time is obtained by the addition of 5-7% CO_2, but in severe cases of poisoning this tends to increase the depression of the respiratory center. Estimations of the actual concentration of CO in the air of towns in various parts of the world have been found to be between 0.001 and 0.046%; most investigators have reported that the COHb of persons exposed to the air of cities is no higher than the average and that no morbid manifestations are present even in workers in tunnels where the concentration of CO has reached 0.0065-0.0085%. In the 2nd part of the article, the authors describe their own investigation of the CO concentration in the air of Rome from Nov. 1954-Oct. 1955 in various zones, at different times and in varying weather conditions, using Drager's apparatus with I_2O_5 as the colorimetric agent. The maximum concentration (0.015%) occurred in the Traforo del Quirinale in cloudy weather during intense traffic. While this is not likely to cause appreciable intoxication in the adult pursuing his ordinary avocations, individuals doing heavy work for 1 1/2 hrs. may experience initial symptoms, and in those spending a great part of their life in places where CO is constantly present may undergo some disturbance which may be aggravated by atmospheric contaminants, e.g., smoke, traces of hydrocarbons, alcohol, hydrocyanic acid and possibly carcinogens. While the authors do not regard CO as the only source of urban atmospheric contamination, they emphasize the necessity of avoiding heavy traffic congestion in streets and the substitution, where possible, of motor-cars by vehicles which do not emit CO. (Abst. Bull. Hyg. 31:929, 1956.)

234. Wilder, C.S.: Environmental cancer in Connecticut. II. Differences in incidence of cancer among areas. Connecticut Health Bull. 70:143-50, 1956.

From 4 areas in Conn. 4357 patients with primary cancer of all sites were interviewed from 1947-50 with respect to occupational histories and hazardous exposures. These areas were comprised of a heavy industrial area, the the urban segment of the textile and paper industry, the rural segment of the same industries and the control area. The incidences of the 1st 2 and of the last 2 were combined to show the difference between urban and rural incidence. Though higher rates were reported for the urban segment of the textile and paper industries than for the heavy industrial area, further analysis revealed no significant difference in these rates. Testing of the significance of all pairs of the 4 areas as well as of the rural vs. urban combinations showed that real differences exist between the urban and rural areas and also that there are more cases of real differences in rates for males than for females. It is suggested that this might be a clue to environmental causes of cancer in males in industrial areas and that urban-rural differences in rates might result from this. Fewer differences in rates are reported for females.

SEE ALSO: Anon. 396; Ascher 421; Shingu 423; Henderson 425; Neal 475; Yant 478; Glebova 533; Dautrebande 540; Randolph 574; Randig 592; Higgins 598; Seelig 630; Kotin 690; Kotin 706.

II. DISCUSSIONS OF ATMOSPHERIC POLLUTION

235. Schaefer, T.W.: The contamination of the air of our cities with sulphur dioxid, the cause of respiratory disease. Boston Med. Surg. J. 157:106-10, 1907.

The author reports in this discussion that, for the 10 years previous to 1907, he had studied the noxious effect of SO_2, and he concluded that it is one of the most patent causes of asthma. It is estimated that for every ton of coal burned, 3 tons of CO_2 are formed. Further, SO2 is formed from the FeS_2 that occurs in ca. 3% concentration in coal. H_2SO_3 is formed from SO_2, and this is very detrimental to buildings and vegetation. Not only may dust particles act as condensing nuclei for fog, but, it is believed, heavy gases, e.g., SO_2 and CO_2, may act similarly. "It is a well-recognized fact that, during periods of heavy fogs in manufacturing centers, the morbidity and mortality from respiratory diseases are increased very greatly, and that, as the atmosphere clears, a sharp decline follows." SO_2 is a local irritant producing coughing, bronchitis and pneumonia. Kiokna (and Ebstein: Z. Hyg. Infektionskrankh. 14:123, 1902.) discovered, in his experiments with SO_2 in rabbits, that the pulmonary capillaries were seriously damaged and the blood itself underwent chemical change. He believes that SO_2 is a protoplasmic poison. He observed that long-continued, small doses affected the lungs seriously. SO_2 inhaled by some people will produce or bring on attacks of asthma. Both qualitative and quantitative testing for SO_2 in the air are described. "The various diseases of the air passages, including pharyngitis, bronchitis, pneumonia and asthma, are materially influenced by meteorological conditions." Legislation and prevention of the pollution of the air are suggested by the author.

236. Klotz, O., White, W.C., Cohoe, B.A., Holman, W.L., Haythorn, S.R. and Shuey, P.: Papers on the Influence of Smoke on Health. Mellon Inst. Ind. Research, Bull. No. 9, 1914, 173 pp.

A. The relation of atmospheric smoke and health. (Cohoe, B.A. 7.)

In 1911, smoke was considered beneficial rather than harmful, even though some suggested its injurious qualities in pulmonary diseases. Some health officers believed that the acid and C particles destroyed lung tissue, were generally detrimental to health and caused disease. Investigators have also noted the higher incidence of death from pulmonary diseases in smoky areas as compared with that in smokeless, rural areas. Inhalation of coal dust leads to chronic bronchitis, followed by emphysema in miners. CO is found in smoke and is poisonous when inhaled in sufficient quantities; CO_2, another constituent of smoke, is produced in almost lethal amounts about some factories. Sulfurous fumes are the most dangerous part of smoke. Arsenic, also found in smoke, lowers man's resistance to disease and infection; N_2 and Cl_2 gases play a minor role in the effect of smoke upon health. Fog is productive of much illness, with an increase in deaths during the week following the fog. Fog diminishes sunlight and causes a decrease in UV rays.

B. Pulmonary anthracosis--A community disease. (Klotz, O. 64.)

The most intense anthracosis appears among coal miners. All city people have some degree of pigment in the lungs. C is very inactive and not detrimental to the person's health. C particles get into the lung

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Klotz, O. et al (continued)
lymphatics and appear in definite areas with a characteristic arrangement.

C. The bacteriology of soot. (Holman, W.L. 104.)
Soot appears to be bactericidal and is not a favorable nidus for the collection of bacteria. Phenols contained in soot are believed to give soot its bactericidal action. Sunlight, too, is bactericidal, but solid particles in smoke may mechanically block this action.

D. Some histological evidences of the disease importance of pulmonary anthracosis. (Haythorn, S.R. 123.)
The anthracotic process in which C particles are deposited in the tissues of organs is described. Anthracosis is inactive in t.b. In severe, acute, inflammatory conditions, anthracosis blocks the lymphatics and the results are detrimental.

E. The influence of smoke on acute and chronic lung infections. (White, W.C. and Shuey, P. 164.)
As the number of smoky days decrease, there is a general tendency for the chronic lung disease (t.b.) death rates to rise and for the acute lung disease death rate to drop. (Abst. Heimann, H. et al.: U.S. Public Health Service, 1950.)

237. Meyers, J.: Cancer death rates, smoke and topography. Am. J. Public Health 20:581-8, 1930.
This is a review on the variation in cancer death rates between countries, states, cities, even adjacent ones, and between parts of cities. The adjusted cancer death rates (age and sex allowed for) in 1920 are given for several states and cities in the U.S.A. Work done in England and Scotland and in France would seem to point to a distinct influence of topography and of combustion products of fuel on cancer death rates. "Where the death rate is low we have a low or high area comparatively flat or at most with low swelling undulatory hills with houses built on the sides, whereas those sections with a high mortality are intersected by gulleys or valleys with houses in the hollows, or the whole section is in the hollow or cup or depression surrounded by higher land." Areas in which coal with high S content is used have a higher incidence of cancer than areas in which peat with low S content is used. The Staten Island cancer study along the lines of these theories, but allowing for age, sex, nativity, nationality, diet, allocation, exclusion of institutional deaths and a 3-year period of residence before death, points to a relationship between smoke and fumes from industrial plants and homes and topography and cancer prevalence. Other statistical, chemical and experimental data point to the influence of smoke and fumes or tar on cancer. What the action and nature of a cancerogenic factor liberated by combustion are is not certain. Whether such a factor is chemical or possibly radioactive in nature is material for other studies. Further studies are now indicated and offer a rich field for an advance in the knowledge of the etiology of cancer in the case of Minneapolis and St. Paul, San Francisco and Oakland and Albany, N.Y.

238. Passey, R.D. and Holmes, J.M.: The incidence of intrathoracic neoplasia in the teaching hospitals of Great Britain 1894-1928. Quart. J. Med. 4:321-44, 1935.

The possible etiology of cancer of the lung is discussed. The increase in smoking and the use of the motor-car have been considered as possible causes by many writers. However, smoking should also have caused increases in cancer of the tongue, larynx and pharynx; but these increases have not been noted. Cancer could be caused by the use of the motor-cars in 2 ways: from the pollution of the narrow streets by exhaust fumes and from the tarring of roads. However, no specific increase in lung cancer among garage hands, taxi drivers, tram or bus drivers and conductors, commercial vehicles drivers or chauffeurs has been noted, and tarring of roads did not become general until after 1918, whereas the increase in cancer has been noted since 1901-5.

239. Ruskin, S.L.: Pollution of the city air as a source of nose and throat disturbance. Science 84:84-5, 1936.

City planning for the control of air pollution is as vital as the control of milk contamination. The poisonous gases issuing from smoke stacks of industrial plants and incinerators are HCl, Cl_2, HF, oxides of N, NH_3, H_2S, CS_2, CO, HCHO and HCN. Oxygen is the most important constituent of air; its source is plant life processes. Air pollution, however, damages vegetation, besides dirtying city streets. Both chemical pollution and smoke dust are harmful. The danger of air pollution is less in summer with more favorable meteorological conditions than in winter. These pollutants cause irritation of the nasal membranes with nasal obstruction and diminished ventilation of the nasal sinuses and thus create conditions favorable to bacterial infection with the ensuing susceptibility to colds and sinus infections. Removal to cleaner air will clear up the symptoms. Ways by which the city can control pollution are suggested.

240. Campbell, J.A.: Cancer of the human lung and animal experiment. J. Ind. Hyg. Toxicol. 19:449-62, 1937.

This is a review of human lung cancer and experimental mouse lung tumors. From a review of the pathology it is concluded that the results from experiments with mouse lung tumors should be applicable to man. The author came to the following conclusions. "Some evidence has been obtained recently both from human statistics and experiments with mice that road dusts (with and without tar) and other dusts increase the incidence of lung tumors. In mice the increase is higher when the tar is also present in the dust. Gases and fumes from internal combustion engines under ordinary circumstances do not influence the incidence of lung tumors. Motor vehicles may, however, play some part by constantly stirring up the fine road dust. Some statistics indicate that workers with tobacco are liable to cancer of the lung and larynx. Some animal experiments give evidence that tobacco smoke and fumes may cause a slight increase in incidence. Further work is required, but this factor does not appear so important as the road dust. Animal experiments indicate that heredity may play an important part in susceptibility to lung tumors. This susceptibility may be increased by subcutaneous injection of certain agents. Even here it is suggested that the irritant or stimulus to start the tumor comes from the external environment. Under ordinary conditions this stimulus may be

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Campbell, J.A. (continued)
below the threshold. The earlier work with animals was of too short a duration to obtain reasonable evidence regarding the effects of dust, etc., upon the incidence of lung tumors and more experiments of a prolonged nature are required. Lung tumors are late in development. So far as the evidence goes it supports the 'irritant' theory for cancer of the lung and indicates that there may be several irritants--coming from the external environment--and several factors, e.g., heredity, capable of exerting an influence. There is no substantial reason why the results for experiments with mouse lung tumors should not be applied to man."

241. Varrier-Jones, P.: Atmospheric pollution in relation to tuberculosis. Diseases of the Chest 4:8-13, 1938.

In this review of the effect of smoke on t.b., the author concludes "that the inhalation of smoke arising from the combustion of coal has no causative effect in relation to t.b., but may and almost certainly does have a protective effect." Further, the incidence of t.b. among coal miners exposed to coal dust alone is below the average, though coal dust contaminated with SiO_2, increases the incidence. However, the review shows that smoke is probably a factor in the causation of cancer. The incidence of occupational cancer was highest among workers exposed to soot and was greater in coal-burning areas than in wood-burning areas. The rest of the paper reports the results of D. Barron Cruickshank's investigation of the relationships of t.b., cancer and Zn.

242. Cohrs, P.: Die chronische Fluorvergiftung der Haustiere vom Standpunkt der Fleischhygiene. (Chronic fluoride poisoning of domestic animals with a hygienic evaluation of the meat from these animals.) Z. Fleisch- u. Milchhyg. 52:1-4, 1941.

In general, this is a discussion of the effects produced by industrial effluents containing F compounds in domestic animals. The author stresses the need for chemical analyses for F in the diagnosis of the disease and for legal purposes. In the hygienic evaluation of meat, Cohrs considers that since the F content of organs and musculature is scarcely increased, and since the use of meat from F-poisoned animals would not extend over prolonged periods of time, it is permissible to use the carcass for human consumption. Even the F content of bones is not injurious, "since a considerable portion disappears in cooking." The meat of slaughtered animals should be graded according to their nutritional state, providing no secondary diseases necessitate a different grading: 1) good to average nutritional state -- good; 2) thin animals -- good; 3) more severe emaciation, without cachexia -- inferior; 4) cachexia with formation of gelatinous bone marrow, serious atrophy of fatty tissue and edema -- unfit. Meat from animals that had suffered diarrhea should also be examined bacteriologically.

243. Loeser, C.: Die Rolle des Schwefeldioxydes bei Schäden durch Feuerungsabgase. (The role of sulfur dioxide in damages through flue gases.) Chem.-Ztg. 66:337-40, 1942.

The author presents the legal aspects of the problem of damages caused by waste gases, especially when SO_2 is one of the constituents. The reasons for and the applications of some German laws pertaining to compensation of these damages are explained.

In the discussion of the toxic effects of SO_2 on vegetation, animals and on man, the following concentrations are pointed out: A SO_2 concentration of 1:500,000 is harmful to roses, which are known to be highly sensitive

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Loeser, C.: (continued)
to the action of the gas. A SO_2 concentration of 12-15 ppm in the air is slightly irritating for man, 400 ppm produce dyspnea, while 500 ppm prevent breathing in adult humans and may lead to their deaths. Children are much less resistant to the effects of the inhalation of SO_2.

The following symptoms are considered typical for the toxic effects of SO_2 in man: irritation of the respiratory tract, convulsive cough, cyanosis of the mucosae, bronchial catarrh, conjunctivitis and frequently also pneumonia as well as dyspepsia.

In the discussion of the amounts of SO_2 given off by burning different types of coal, the author assumes an average content of 1% of combustible S in the coal. Depending on the type of coal burned, the waste gases given off through the chimney may have a SO_2 concentration of 200-4000 ppm by volume.

Various attempts and methods to render the gas harmless are described, such as endeavors to induce increased dilution of SO_2 in the air or to construct various devices within the chimney. The great influence of the wind velocity on the toxicity of the waste gases is stressed.

In the conclusion, the author describes a cone-shaped hood which he had designed and which seems to contribute to the solution of the problem of detoxication of waste gases. The hood is built into the chimney and provides great additional amounts of air which join the waste gases before these leave the chimney. Thus, they are diluted before being given off and also escape with greater velocity, which, in turn, causes increased dilution of the gases in the atmosphere.

244. Mills, C.A.: A practical approach to the problem of urban air pollution. Cincinnati J. Med. 22:502-7, 1942.

The author considered smoke in its broadest sense as including all impurities put into the atmosphere from the city's fires, and discussed the damaging effects of individual impurities on health.

Carbon soot: The least harmful to health, as C particles have no known disease producing action.

Fly ash: Constitutes large part of sediment falling on city daily. Similar in constitution to rock dust, it is now believed that not only is fly ash harmful because of its sharp cutting edges, but that by dissolving in tissue fluids it can cause chemical irritation. It is suspected of being related to the onset of tuberculosis and to chronic sinus inflammations as soft coal-burning cities of the Ohio Valley are among the country's worst for these diseases.

Flue gases: S oxides probably add to irritating effects of pollution. Burning of high volatile coals gives off definitely harmful substances. Carcinogenic compounds have been isolated from coal tar and from city atmospheric dust and have been found to volatilize at low temperatures (280°C). They are also found in crude oil, and in most coals of lower volatile content, in amounts roughly proportional to the % volatility. High cancer rate among chimney sweeps first brought attention to presence of these compounds in coal tar and coal smoke. Coal tar compounds injected into mice almost always produce typical malignant cancer. Cancer of the lungs is the leading type of cancer in men, especially in low income city groups. Cancer mortality is greater in cities such as Pittsburgh and Birmingham than in cities with less pollution.

Steam: The steam liberated from power production is the factor most responsible for dense "smogs" of colder months. On windless days the great amount of steam causes combustion products to be held suspended for weeks at a time, thus causing city dwellers to breathe poisonous

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Mills, C.A. (continued)
mixtures. Feeling the steam factor to be important, Mills calculated the amount of steam probably given off by steam engines in a day (ca. 210 billion grains). With this amount in the air, condensation would take place with a 15°F. drop in temperature at night in winter, and produce fog on windless days. Remedial measures are suggested. A table is included showing H_2O vapor in the air at different seasons.
From a health viewpoint, the author suggests: (1) use of high-volatile coals be avoided in the city; (2) lessen the amount of fly ash and (3) use of noncondensing steam engines be prohibited or sharply curbed.

245. Henderson, Y. and Haggard, H.W.: Noxious Gases and the Principles of Respiration Influencing Their Action. New York, Reinhold Publishing Co., Inc., 1943, 294 pp.
The material in this book is treated under the following chapter headings: General survey of the field; Elements of respiration; The respiratory functions of the blood and their laws; Practical applications of the laws of gases and vapors; Principles determining absorption, distribution and elimination of volatile substances; The significance of standards for physiological response to various concentrations of gases and vapors; Classification of noxious gases and vapors; Group I. Irritant gases; Special characteristics of various irritant gases; Group II. Asphyxiation and simple asphyxiants; Chemical asphyxiants; Group III. Volatile drugs and drug-like substances; Group IV. Inorganic and organometallic gases; Methods of resuscitation and comparison of various treatments. First aid; Prevention of poisoning by noxious gases and also Supplementary statement on breathing machines.

246. Heating and Ventilation (Reconstruction) Committee, Building Research Board, Department of Scientific and Industrial Research (Egerton, A.C., Chairman): Heating and Ventilation of Dwellings. Ministry of Works, Post-War Building Studies, No. 19. London, Her Majesty's Stationery Office, 1945, 228 pp.
The chapters cover the following topics: domestic heating; basic requirements for heating and ventilation; factors affecting the amount of heat needed in dwellings to maintain the conditions defined in chapter 2; insulation of dwellings; importance of amenities; relative efficiencies of methods of using the national coal resources for the heating of buildings; choice of methods of heating; ventilation of dwellings; supplementary services associated with the heating of dwellings; rural housing; foreign practice; development, installation and operation of heating appliances; testing, specification and standardization of heating appliances and fuels and fuel distribution. Most of the chapters contain useful tables of statistical information. The bibliography is very incomplete. In the chapter on the importance of amenities, atmospheric pollution is discussed briefly as to the nature of atmospheric pollution, smoke, ash, SO_2, effects, cost, pollution as a factor in choice of appliances and national policy.

247. Stern, A.C.: Atmospheric pollution due to dust and cinders. Heating and Ventilating 42, No. 7:85-8, 1945.
Aside from the natural processes of disintegration and attrition of mineral, plant and animal substance and from the mere habitation of an area, enough minute particles of matter are discharged from chimneys and stacks to so pollute the atmosphere of large population centers as to make air pollution a major problem. The methods in use for measuring dust

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Stern, A.C. (continued)
content of the atmosphere are described: (1) A measured volume of air is drawn through a filter paper, which is weighed before and after; (2) in the Owens jet dust counter the dust particles are collected on a slide and counted microscopically; (3) sootfall over a period, e.g., a mo., is measured by deposition in a jar of known cross section. The accuracy of the methods is discussed, as well as the significance of the data so obtained. Abatement measures are also considered.

248. Stern, A.C.: Atmospheric pollution due to gas. Heating and Ventilating 42, No. 2:73-4, 122, 1945.
Flue gas is discussed as the principal source of gaseous air pollution in cities. The principal contaminant of flue gas is CO_2, of which the maximum concentration found in cities is 0.04% with no known deleterious or objectionable effect upon either plant, animal or human life. Most flues also contain CO along with the CO_2 and "CO concentrations such as exist in even highly polluted atmospheres are not known to adversely affect either plant life, materials or structures." Other studies have shown that traffic policemen are unharmed by CO exposure. CO therefore presents no problem as an atmospheric hazard. "Although concentration of SO_2 in air >1 ppm will mark or kill vegetation, those <0.2 ppm cause no known damage to plant life." The generally accepted maximum allowable concentration of SO_2 for human exposure is 10 ppm, which is considerably higher than any atmospheric concentration yet recorded other than in the direct wake of gases from a particular stack. It is conjectured that a concentration of 40 ppm was reached in the 1930 Meuse Valley disaster. (Abst. Heimann, H., et al., U.S. Public Health Service, 1950.)

249. Stern, A.C.: Atmospheric pollution due to smoke. Heating and Ventilating 42:67-70, 1945.
"The pollutant best able to stabilize a fog is SO_2 which in a mist can oxidize to SO_3. A droplet of H_2SO_4, the form in which SO_3 would exist in a mist, will be stable at a lower relative humidity than a droplet of H_2O. Therefore, once a fog is formed in an atmosphere containing SO_2, it will tend to be a more presistent fog than one in an unpolluted atmosphere. It will be a more objectionable one because of its corrosive and irritant character." The adverse effects of smoke include dirtying of clothes and buildings, clogging of plant pores, decreasing of atmospheric visibility and loss of daylight and UV light. As for effects on health, the report of the Committee on Public Health Relations of the N.Y. Academy of Medicine is cited: "Inhalation of C particles and irritating fumes lower the resistance of the nasal mucous membrane, rendering it susceptible to acute and chronic infections which may involve the ear. Enlargement of the tonsils and redness and congestion of the pharynx and larynx have also been ascribed to atmospheric pollution. Smoke likewise irritates the membranes of the entire respiratory tract, predisposing to pneumonia and emphysema. Smoke diminishes the potential reserve, working capacity, and well-being of the individual and increases fatigue and irritability, whereas sunshine exerts an exuberant influence." The methods of measuring the density of smoke discharges by the Ringlemann chart or the Umbroscope or by a photocell in the stack are described. Measurement of suspended impurity, in particular with the Owens Automatic air filter, is also discussed. The difference is smoke production of various fuels is also discussed.

✓250. Gill, G.H.: Dust and Its Effects on the Respiratory System. London, H.K. Lewis and Co., Ltd., 1947, 50 pp.

This is a review of the subject in brief form and discusses, in general, respiration, physiology of the lung, respiratory diseases and testing technics. The bibliography is very limited.

✓251. Marsh, A.: Smoke. The Problem of Coal and the Atmosphere. London, Faber and Faber, Ltd., 1947, 306 pp.

The chapter headings are as follows: the first coal age; combustion and smoke; smoke in the atmosphere; smoke as a health problem; air pollution and plant life; the destruction of property; the squalor of smoke; the cost of smoke; the indictment grows; the second coal age; the abatement of smoke; what has been done; the problems of industrial smoke; the problems of domestic smoke; a plan for progressive action; organization for smoke abolition and the problem of public opinion.

Ash, suspended matter and SO_2, and their measurement by deposit gauges, automatic filters and volumetric and PbO_2 methods are discussed in the chapter on smoke in the atmosphere. The usual daily, weekly and seasonal cycles and the difference in readings for rural, suburban and city areas are pointed out. The interaction of fog and smoke, inversion, the action of wind and the turbulence of the air in dispersing fog, and obstruction of UV light by smoke are also discussed in this chapter. In the chapter on smoke as a health problem, the following points are covered. Smoke reduces sunlight, thus helping to make rickets more prevalent. In fact, the rickety pelvis, a serious risk to both mother and child during parturition, is believed to be commoner in the smoky districts. Smoke pollution is regarded "as a contributory factor, sometimes a powerful one, in diseases, disorders and symptoms possessing other causative factors." Its most common effect is irritation of the mucous lining of the entire respiratory tract and surfaces. Pigmentation and deposition of C particles in the lungs from smoke will promote bronchitis and bronchopneumonia. However, this same factor is believed to inhibit pulmonary t.b. The general effects of continued respiration of "normally" polluted air are insidious, gradual and subtle wherein lies its danger. Dense or prolonged fog produces definite discomfort and distress, especially to asthmatics, with smarting of the eyes and immediate irritation of the respiratory tract, followed by coughing, wheezing and other symptoms of inflammation. The consequences of these dense fogs are reflected not only in an increased incidence of illness but in mortality tables. In the London fog of 1873, the death rate rose to 37.5. In the fog of 1880, the death rate in London rose from 27.1-48.1, while right outside London it rose only from 35-36. In the London 1922 fog the death rate rose from 11.8-14.3, while in the rest of England and Wales it increased 11.5-12.6. Besides these effects, the psychological effects of lack of brightness and the drabness and dirtiness of smoke are serious effects on the health of man. The sum total of all these consequences is likely to be more than the arithmetical aggregate. It is further emphasized "that the factors affecting health are probably more serious in their total indeterminate effects than in the incidence of recognizable disease attributable to them."

252. Anonymous: Sulfur dioxide poisoning. Queries and Minor Notes. J. Am. Med. Assoc. 138:1006, 1948.

This is a concise summary of known data on SO_2 inhalation, mainly poisoning in industry, and includes the lethal dose, toxicity and symptoms caused by inhalation, complications and disability. "The

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action of SO_2 is not persistent, so that a true chronic state does not arise except that chronic exposures perpetuates acute manifestations. .... On rare occasions it is possibly true that a condition of allergy, or akin to allergy, develops to the end that subsequent trivial exposures excite responses out of proportion to those expectable."

253. Johnstone, H.F.: Technical aspects of the Los Angeles smog problem. J. Ind. Hyg. Toxicol. 30:358-69, 1948.
The Los Angeles smog problem results from the topographical and meteorological features of the area which control the escape of the industrial and domestic pollution. Exact information on the nature of the smog is still lacking, but certain aspects of the problem are related to the general properties of aerosols. It is estimated that the nonhygroscopic, nonvolatile particles are approximately the size of the wave length of light, i.e., ca. 0.3-0.5 µ, and exist at concentrations of about 0.1 mg./m^3. There are some indications that SO_2 may contribute directly to smog formation. SO_3 and H_2SO_4 contribute to mist formation. The contributions of S compounds to eye irritation are discussed rather briefly. Methods of eliminating them from industrial gases are reviewed. New developments in the equipment for the control of dust and fumes are described.

254. National Smoke Abatement Society(London): Guilty Chimneys: Evidence of Authorities Against Smoke. London, 1948, rev. ed., 20 pp.
Quotations from official sources of the damage caused by smoke are given.

255. Neuberger, H.: Condensation nuclei. Their significance in atmospheric pollution. Mech. Eng. 70:221-5, 1948.
There are 2 general types of aerosols in the atmosphere, the so-called "neutral" particles, commonly known as dust, and condensation nuclei which are made up of hygroscopic substances. The former range in size from ca. $3 \times 10^{-5} - 10^{-3}$ cm. and larger; they are of more nuisance but are less harmful than the condensation nuclei. These latter consist of Cl^- salts, H_2SO_4, P compounds, N oxides and HNO_3, range in size from $10^{-7} - 10^{-5}$ cm. and weigh $10^{-14} - 10^{-18}$ g. The natural sources are volcanic eruptions, spray from ocean surfaces, combustion products and from forest fires, exhalations from living or decaying vegetation and bacteria. Artificial sources include industrial furnaces and processes of various kinds, transportation exhausts and domestic fires. Due to their hygroscopic character, these nuclei grow in size as the relative humidity increases above 70%, and haze and fog are formed. The greater the concentration of these droplets, the faster they grow and the greater the density of the cloud they form. Not many nuclei are needed to produce a dense cloud, ca. 300-500 nuclei/cc. In a unit volume of fairly clean air, the nuclei are ca. 50 times as numerous as the dust particles. In industrial cities, the dust particles represent only a fraction of 1% of the total amount of suspension found in the air. In the free atmosphere, the nuclei exceed dust particles by a factor of several thousand due to greater amount of sedimentation of the larger dust particles, and greater ease of wind transport for the nuclei. Inconsistent results have been reported on the effect of precipitation on dust and nuclei. Exposed surfaces are corroded by nuclei containing Cl_2, S and NH_3. The biological effects of the nuclei on human beings are discussed. Though reduction of sunlight, particularly UV light, by dust and nuclei occurs, this is not thought to be

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Neuberger, H. (continued)
too serious since most city residents do not spend much time outdoors anyway and, further, sunlight has been found to cause a high incidence of skin cancer among outdoor workers. Very little factual data are available on the effect of the nuclei on the human respiratory system. Studies of the retention of condensation nuclei in the respiratory tract have shown that even if 150,000 billion nuclei/year were retained, the body's weight increase would be only 15 mg./yr. However, the acrid sensation felt in the throat from H_2SO_4 nuclei is quite unpleasant and it is also conjectured that the inhaled ions or electrically charged nuclei may be responsible for restlessness and psychological depression. Dust is considered to be of less biological significance due to its fewer numbers and greater ease of nasal filtration.

256. Stern, A.C.: General atmospheric pollution. New York City's atmospheric pollution control problems. Am. J. Public Health 38:966-9, 1948.
Air pollution control problems and their control in N.Y. are considered. Since 1903 the city has had a sanitary code prohibiting discharge of annoying emanations of smoke, cinder, gas, steam and offensive odors. In 1937 a building code was adopted, which included the requirement that plans and specifications for fuel-burning installations must be filed with the commissioner of Housing and Building before installation. It was also stipulated that fuel equipment should be designed not to discharge smoke, soot, cinders or fly ash in such quantities as to cause annoyance to the public or injury to business property. The Health Department has estimated that the Smoke Unit initiated >$2,000,000 worth of plant modernization and improvement during the past year, and $3,500,000 worth in the year to come. (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

257. Whittaker, H.A., Chairman: Air pollution. Engineering Section, Am. J. Public Health 38:761-9, 1948.
This is a rather comprehensive review of atmospheric pollution and its problems up to 1948. It discusses the nature, sources, distribution, effects, engineering prevention and legal control of atmospheric pollution. Though health hazards were recognized, little epidemiological work to prove it had been done as yet. The control programs in New York City, St. Louis and Los Angeles are reviewed in particular. The control of air pollution requires a great amount of work by both public health workers and engineers.

258. Clayton, G.D.: Public health aspects of atmospheric pollution. Am. Ind. Hyg. Assoc. Quart. 10:64-7, 1949; Ind. Hyg. Newsletter 9:10-2, 1949.
Atmospheric pollution is a universal and complex problem. The 2 broad phases of the problem of effects and contaminants are discussed briefly. The effects are considered under the headings of nuisance, economics, vegetation, animals and health. Little is really known of the way in which air pollution affects health. The scope of the studies necessary to determine the chronic effects is indicated. The contaminants are grouped as gases and vapors and particulate matter. The following methods of control of contaminants are discussed: substitution, conversion, collection and dilution. Ordinances against air pollution must be based on the conditions of the individual community and need the support of all in the community.

259. Drinker, P. and Cook, W.A.: Maximum allowable concentrations of atmospheric impurities. J. Ind. Hyg. Toxicol. 31:51-4, 1949.
Atmospheric impurities can be tolerated safely at concentrations which vary with the toxicity of the compound and the duration of exposure. Only a few substances, like CO, have such well defined systemic effects that safe exposures can be defined with a high degree of precision. Most others, like benzol and CCl_4, fit best into zones of toxicity. Six such zones are set out for a number of representative substances ranging from the least harmful, like acetone, at concentrations ranging from 500-2500 ppm to the extremely toxic, like Rd gas, at concentrations below 0.1 ppm. It is believed that this classification of contaminants should be of practical value in the understanding and control of industrial health hazards. (Authors' summary.)

260. Knapp, H.J. and Dyktor, H.G.: Health aspects of air pollution. Bull. Acad. Med. Cleveland 34, No. 8:5-8, 1949.
From the evidence thus far available, air pollution often contributes a nuisance, but except under extremely unusual conditions, atmospheric contamination is not sufficient to cause specific disease or death. Aside from economic aspects the general well-being and comfort of a community may be seriously affected. Extreme care must be exercised in any attempt to establish direct causal relationship between air pollution and changing trends of diseases affecting the respiratory tract. In working with crude statistics certain data may be suggestive of possible relationships. In attempting to correlate changing trends in any disease with a given cause crude statistics do not suffice. In any given study it is essential to break down population groups accurately tabulated into age and sex categories and relate such data to a standard million. Some of the death rates from cancer, pneumonia and pulmonary t.b. in Cleveland are used to illustrate these points. (From authors' summary.)

261. McCord, C.P. and Witheridge, W.N.: Odors: Physiology and Control. New York, McGraw-Hill Book Co., Inc., 1949, 405 pp.
The material in this book is presented under the following chapter headings: The anatomy of the olfactory system; the physiology of the olfactory sense; chemical constitution and odors; odor classification; odor detection and measurement; the pathology and perversions of the olfactory system; the influence of odors on health and comfort; human body odors in health; human body odors in disease; odors in the diagnosis of disease; household odors; odors of waters and foods; industrial odors; the offensive trades; air conditioning and odors; chemical and physical destruction of odors; odor masking; odor cancellation and counteraction; the sorption of odors; odors as warning agents; odor repellents and odor attractors; the making of an odor survey and the legal aspects of odor nuisances. An extensive bibliography covering 124 pages is given.

262. Swain, R.E.: Smoke and fume investigations. A historical review. Ind. Eng. Chem. 41:2384-8, 1949.
The history of air pollution in Germany and in England is briefly reviewed. A few outstanding cases of injury to animal and plant life by industrial emanations at Ducktown, Tenn., Anaconda, Mont., Salt Lake City, Utah and Trail, B.C. are discussed with respect to what happened, what was done about it and something of what was learned from them in regard to the handling of air-borne wastes and the detection and

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Swain, R.E. (continued)
appraisal of injury done. The contributions of research in the 2nd decade of this century to the broad question of smelter smoke injury, e.g., the Marston-Wells method for SO_2 determination in air, a new method for controlled fumigations of plants and the relating of meteorological conditions to smoke troubles, are also reviewed.

263. Baetjer, A.M.: Chronic exposures to air pollutants and acute infectious respiratory diseases. Arch. Ind. Hyg. and Occupational Med. 2:400-6, 1950.

Attempts have been made to relate pneumonia mortality rates of the general population to atmospheric pollution expressed in terms of soot-fall, but mortality rates are affected by too many factors. Studies of exposure to specific atmospheric contaminants as in industry and experimentation on animals give data that are limited in certain respects, but are more reliable. The industrial exposure and animal (mainly rats) experimentation studies relating morbidity and mortality rates to non-toxic dusts, e.g.,SO_2, coal dust, Al, feldspar and cement; smoke; irritant gases and fumes, e.g., SO_2, Cl_2, nitrous fumes, etc.; asphyxiant gases, viz., CO and other materials, e.g., F^-'s, metals and organic materials are rather briefly reviewed. These studies indicate there are much conflicting data and little definite evidence that chronic inhalation of such chemical contaminants in low concentrations affects susceptibility to acute infections of the respiratory tract. Therefore, the data available at present are entirely insufficient to enable one to draw any definite conclusions; more fundamental research is needed.

264. Bloomfield, J.J.: Health implications of air pollution. Proc. Air Pollution and Smoke Prevention Assoc., Amer. 1950:76-81.

This is a general discussion of the problem. The results of the Donora investigation are reviewed. Research on health aspects has many questions to answer. For example, to what extent does damage to the respiratory system affect the cardiovascular system; what special effects does air pollution have on children and the elderly; and does the loss of sunlight lessen a child's resistance to disease? Caution is necessary in establishing limits in ordinances; if too severe, industry may be forced to leave, or shut down. Limits should be such that the average person is protected. By using available scientific techniques and apparatus, industry, the home and transportation, and other sources of contamination can reduce their air pollution load despite the gaps in existing knowledge in this field.

265. Brandt, A.D.: Problems of air pollution. Iron Steel Eng. 27, No. 6: 75-83, 1950.

This is a general discussion of the air pollution problem with respect to contaminants, meteorology and topography, effects and engineering and regulatory control. In particular, the data on SO_2 concentrations in Detroit, Philadelphia-Camden, Pittsburgh, St. Louis-E. St. Louis and Washington in 1936-1937 are quoted from Meller, H.B., Allen, J.D. and Sherrick, J.L.: Concentrations of volatile sulfur compounds in atmospheric air. Special Research Series, Bull. No. 1, Part 2, Air Hyg. Foundation of Am., Inc., Pittsburgh, Pa., 1938. The values were highest for St. Louis-E. St. Louis (total average-0.060 ppm), and then for Pittsburgh (0.038 ppm), for Philadelphia-Camden (0.022 ppm), for Detroit (0.014 ppm) and least for Washington (0.002 ppm). 33 references were cited.

266. Dunning, J.M.: Effects of air pollution on oral structures. Arch. Ind. Hyg. and Occupational Med. 2:137-9, 1950.

Some 42 agents have been recorded at one time or another as producing effects on the oral structures. Most of these occur in occupational exposures and local air pollution. Examples of these are given. F is about the only etiologic agent in general air pollution. Detailed knowledge of industrial hazards to the oral structures is at present so scanty and the chance so great, that the dentist can be a valuable scout for the medical team; thus it is urged that dentists be included in all the public health teams doing epidemiologic work. Further, the dentist can appraise the level of nonoccupational dental disease in the area.

267. Foulger, J.H.: Physiologic effects of chemical contaminants of the atmosphere. Proc. 1st Natl.Air Pollution Symposium, Pasadena, Calif., Nov. 10, 11, 1949: 121-8, 1950.

A general theory of the effect of physiologic stress, wherein 2 or more chemicals in low concentration combine their effect in a "compound interest" summation, is mathematically developed. Irritant chemicals in the atmosphere affect the eyes and upper respiratory tract causing sneezing and coughing. The special physiological cycle set off by these reactions, in which the circulatory balance is disturbed, is discussed in detail. Nonirritant chemicals, or chemicals in concentrations below the toxicological levels, do not elicit sneezing and coughing, and therefore the vicious cycle is not started. However, combinations of 2 or more chemicals in low concentrations conform to the general theory in producing physiological deterioration. If enough recovery time is allowed, the effects of an exposure that does not last too long will be overcome, as shown in the Brooklyn Cl_2 and phosgene incidents, with no pathological after-effects. However, if a 2nd exposure is experienced before recovery of the 1st or if prolonged exposure occurs as in the Meuse and Donora incidents, pathological results will occur. The author refutes the idea of the possibility of "new" diseases from atmospheric pollution in the light of the above discussion. Though irritation of the eyes occurs most frequently from smog and causes temporary disorder, there are very few chemicals that have a drastic or permanent action upon the eye.

268. Heimann, H., Brooks, H.M., Jr. and Schmidt, D.G.: Biological Aspects of Air Pollution: An Annotated Bibliography. U.S. Public Health Service, 1950.

This annotated bibliography contains 321 references.

269. Hueper, W.C.: Environmental cancer hazards caused by industrial air pollution. Arch. Ind. Hyg. and Occupational Med. 2:325-8, 1950.

Soot has been considered the commonest cancer-producing factor in air, causing cancer of the lung and scrotum. Many other industrial products are now considered cancer-producing, e.g., products of the combustion and fractionation of coal, mineral oils, shale oils and natural gas, aromatic amines and arsenical, chromate, beryllium, asbestos and radioactive dusts. Cancerigenic agents polluting the air may enter the body by inhalation, cutaneous contact or ingestion and may cause cancers affecting the lung, nasal sinuses, other parts of the respiratory tract, skin, bone, bone marrow and bladder. The future control of these potential hazards in a locality depends on reliable qualitative and quantitative demonstration of the agents, epidemiological studies of cancer incidence and institution of effective measures against release of the agents into the air. A list

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Hueper, W.C. (continued)
of cancerigenic agents, types of contact and sites of cancer are tabulated.

270. Johnstone, H.F.: Properties and behavior of air contaminants. Ind. Med. Surg. 19:107-15, 1950.
S gases and vapors, N and halogen compounds, CO, CO_2, exhaust gases, peroxides and O_3 are discussed as to their physiological effects, sources, prevalence and means of removal. Aerosol contaminants are discussed as to their physical properties, viz., effect on visibility, deposition, coagulation, evaporation, Brownian diffusion, electrical properties, dispersion and physiological effects, and sources. The gases and vapors present in contaminated air are of interest mainly from their chemical behavior, e.g., conversion to obnoxious compounds by reaction with other contaminants, or with O_2 in sunlight, whereas the physical properties of aerosols of suspended particulates, e.g., effective particle size, are of most importance. (19 references cited)

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271. Kehoe, R.A.: Air pollution and community health. Proc. 1st Natl. Air Pollution Symposium, Pasadena, Calif., Nov. 10, 11, 1949:115-20, 1950.
What is known about the nature and extent of the inhaled pollutants of industrial origin on health has been obtained from studies in industrial toxicology, medicine and hygiene, from the study of acute episodes, and from statistical correlation of air pollution measurements and morbidity and mortality statistics. MAC values for industrial exposures have a limited application to community air pollution exposure. The concentrations of the pollutants CO, Cl_2, H_2F_2, N oxides, SO_2, Cd, Pb, Mg and Zn found in the rural and residential areas and the commercial and industrial areas in Cincinnati for 1947-49 are compared with MAC values and are found to be considerably lower. (The results of analyses of the atmosphere in Donora are also included.) Unfortunately, the knowledge on which MAC values are based is deficient because not all industrial materials have been studied accurately, it is not known if the effect of combinations of pollutants is more or less additive, and human exposure is not necessarily the same as animal exposure. The meteorological factors and terrain also affect air pollution, especially in acute episodes.

272. Larson, G.P.: Reduction at the source. Proc. 1st Natl. Air Pollution Symposium, Pasadena, Calif., Nov. 10, 11, 1949:77-9, 1950.
A program to reduce air contaminants at the source supported by regulatory laws is broadly outlined. These laws should include setting up emission standards, a nuisance statute, licensing of fuels and installation under a permit system. Several features of the Los Angeles control program are generally discussed.

273. McCabe, L.C.: National trends in air pollution. Proc. 1st Natl. Air Pollution Symposium, Pasadena, Calif., Nov. 10, 11, 1949:50-4, 1950.
The author reviews the more rapid progress made in air pollution abatement in this country in the previous few years. More interest has been stimulated recently as is shown by the many air pollution symposia being held, the effective installation of control equipment in industry and the developments in new equipment. Cooperation among scientists, engineers, citizens and communications against air pollution is needed. The elements of a successful abatement program are (1) an aroused public support; (2) vision; (3) continuous effort; (4) a sound enabling act and (5) technical skill.

274. Pond, M.A.: Environmental health and the aging population. Am. J. Public Health 40:27-33, 1950.

Some of the health problems associated with the aging population, e.g., environmental cancer, heart disease, mental health, housing, accidents, atmospheric pollution and care of the chronically ill are discussed in relation to the significance of the physical environment and to the role of the engineer in chronic disease prevention and control. The artificial environment of our industrial society has created more serious carcinogenic potentialities. Interest in cancer control must be stimulated. In the various acute air pollution disasters, the excess morbidity and mortality occurred in the age group 45 and over. Are older people especially susceptible to the hazards of atmospheric pollution, and what specific air pollutants are most significant in producing excess morbidity and mortality? Answers to such questions will be important in planning and operating community-wide projects for the control of air pollution, and will also play a role in increasing life expectancy.

275. Schrenk, H.H.: Causes, constituents and physical effects of smog involved in specific dramatic episodes. Arch. Ind. Hyg. and Occupational Med. 1:189-94, 1950.

The causes, constituents and physical effects of smog involved in the Meuse Valley and Donora atmospheric pollution episodes are discussed by critically reviewing the official report of the Meuse Valley incident and the work being done in the Donora investigation. The author comments that the exact cause of the Meuse Valley incident was not established beyond all doubt, and nothing conclusive about the Donora study can be said at this time. In studying atmospheric contaminants, continuous exposure over many hours, effects on the aged, persons with impaired health and hypersusceptible and allergic persons, effects of simultaneous exposure to several toxic substances, the role of extremely fine particles in absorbing and transporting toxic gases or vapors to the alveoli and the possible influence of atmospheric pollution on common diseases must all be considered. The Division of Industrial Hygiene, U.S. Public Health Service, has planned to conduct investigations and undertake fundamental research covering this entire field of air pollution.

276. Stokinger, H.E. and Laskin, S.: Air pollution and the particle-size toxicity problem--II. Nucleonics 6, No. 3:15-31, 1950.

This is a review of the methods and instruments of recent origin that are especially suited to aid in the solution of problems posed to industry and communities by air-borne particles. The instruments described in particular are: the filter paper dust sampler and the electrostatic precipitator for quantitative estimation of particulate concentration; the Modified Cascade Impactor and the oscillating thermal precipitator for characterization of particle-size distributions; surface-coating techniques as improved methods of resolution and measurement; the Penetrometer and the Owl, indirect optical methods for characterization of particulates and low-temperature ethane adsorption for the measurement of surface area. (36 references.)

277. Townsend, J.G.: Investigation of the smog incident in Donora, Pa., and vicinity. Am. J. Public Health 40:183-9, 1950.

This article discusses the situation in Donora, Pa., after the smog episode of Oct. 1948 when the Public Health Service began its investigation, and it reviews much of the procedure of the investigation.

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Townsend, J.G. (continued)
This information is also contained in Schrenk, et al.: Air Pollution in Donora, Pa., Public Health Bull. No. 306, Washington, D.C., Federal Security Agency, Public Health Service, Division of Industrial Hygiene, 1949, 173 pp. It is concluded that "industrial hygienists, by their training, interests and basic functions in the public health field, have no choice but to enter the field of atmospheric pollution, as they have attacked other toxic hazards. The problem is too titanic for any one agency to cope with alone. The operation will be a long-range one and will require the efforts of physicians, engineers, chemists and others."

278. Wittich, F.W.: Respiratory tract allergic effects from chemical air pollution. Arch. Ind. Hyg. and Occupational Med. 2:329-34, 1950.
Pollution from common atmospheric mold fungi, smuts, rust and other allergens infesting the grains, and grain and "feed" mill dusts, including insects, which cause all types of respiratory allergies are discussed. Numerous insecticides in common use have been shown to have allergenic specificity because of the chemicals employed with them. A few of the cases of asthma caused by exposures in various occupations and industries are reviewed. Local aggravations of asthma as occurred in Donora and is occurring in Los Angeles are mentioned.

279. Adams, E.M.: Physiological effects. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 5, 1951, 28 pp.
The physiological effects of air pollution on man, both toxic and sensory, and on animals and vegetation are reviewed by (a) describing the nature and significance of the varied effects which are possible, (b) indicating the nature and extent of the difficulties which have been experienced, (c) outlining the requirements for adequately establishing a causal relationship between pollution and physiological effect, (d) indicating physiological methods and information useful in handling problems. This summary relies on a series of recent review papers for most of the information dealing directly with atmospheric pollution. Other information has been obtained from publications located through the last 20 volumes of Chemical Abstracts and also from the somewhat dispersed toxicological literature. 89 references are cited and 5 tables consisting of MAC values, concentrations of atmospheric contaminants reported in various locations, odor thresholds, concentrations of substances causing pain in the eyes and exposures to substances causing injury to vegetation are included. About 27 atmospheric contaminants are reported in quite a few locations under various conditions and are compared with the MAC values. The concentrations of ca. 70 substances causing pain in the eyes are reported both in ppm and in mg./l.

280. Allcut, E.A.: Air sanitation. Eng. J. 34:664-71, 1951.
The prevalence of atmospheric pollution in general, but more particularly in Great Britain, is discussed. The preliminary indications of a survey of conditions in the city of Toronto started in 1951 show that the situation has not changed markedly since 1933. The effect of low levels of pollution on health has, in general, been considered tolerable, but evidence of the relationship of the incidence of respiratory diseases to the prevalence of fogs and the build-up of concentrations of toxic substances is recognized. The air pollution incidents in Donora, the Meuse Valley, Poza Rica, Los Angeles and Trail, B.C. are reviewed. What constitutes an "offensive" odor and the

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Allcut, E.A. (continued)
general allowable limits of pollution in Canada are discussed. The size of particles is an important factor in the effects and control of air pollution. Better instrumentation and measurement must be developed. The advantages and disadvantages of reduction of pollution by mechanical and chemical separators and by electrical and sonic precipitation are reviewed. Organization on a national basis for better pollution control is needed.

281. Bulkley, R.J.: Community relations. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 3, 1951, 8 pp.
This is the third of a series of 12 pamphlets dealing with separate phases of air pollution abatement as related to the chemical and allied products industries. Air pollution presents 2 distinct sets of problems - those of an engineering nature and those dealing with community relations. Methods of abatement are almost entirely engineering problems. The reason for abatement is almost entirely the community-relations problem engendered by pollution. The first requirement of a sound community-relations program for any company is that the company must act properly in good faith, not only in dealing with problems of air pollution but in every phase of its business conduct. This is basic. Without good conduct and good faith, the rest of the program, no matter how skillfully conceived, will lack foundations and sooner or later will fall to the ground. Assuming that this basic requirement is met, the next step is to let the community know that the company is acting in good faith and to seek community understanding of the company's problems and actions.
(Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

282. Cralley, L.V.: Analytical methods. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 7, 1951, 16 pp.
The objective of an analytical procedure in air pollution studies is to obtain information that can be attained only when the over-all sampling-analytical setup permits the assignment of figures of significance. It is evident then that the following requirements must be satisfied: (1) Collecting efficiency of the sampling equipment in the concentration range to be reported must be known; (2) sampling equipment must be selected to produce a minimum alteration in the composition of the substance to receive critical study; (3) equipment and reagents must produce "blanks" smaller than the amount of material collected in the lowest reported concentration; (4) an adequate amount of material, in a form suitable for analysis, must be collected and (5) measuring procedures must be of satisfactory reliability and sensitivity. The aim is to show the application of these procedures in the field of air contamination analysis rather than to duplicate the theory and technics that have already been so well presented in the literature. (145 references cited.) (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

283. Gillet, J.M.: Introduction to a manual of air pollution abatement. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 1, 1951, 5 pp.
This is the first of a series of 12 pamphlets dealing with separate phases of air pollution abatement as related to the chemical and allied products industries. Historical and recent developments and responsibility for abatement are discussed briefly. Air pollution as discussed in the manual is defined as "the presence in the air of

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Gillet, J.M. (continued)
substances put there by the acts of man, in concentrations sufficient to interfere with the comfort, safety or health of man, or with the full use and enjoyment of his property."
(Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

284. Hunter, D.: Fluorosis and berylliosis as industrial and community health hazards. In: The Application of Scientific Methods to Industrial and Service Medicine. (Proceedings of a conference held from Mar. 29-Mar. 31, 1950). Medical Research Council. London, H.M. Stationery Office, 1951, pp. 40-9.

The occupational hazards of F and Be are reviewed briefly. The following comments apply to F exposure. In Great Britain the bones of those workers in fluorspar, enamel and glass, whose chests have been examined radiographically for evidence of pneumoconiosis have been found free from fluorosis. The first case of bone involvement was reported by Bridge in 1941. The investigation by the Medical Research Council (1949) in the neighborhood of Al factòries in Inverness-shire is included in the discussion with mention that no definite evidence was found of harmful effects on the health of persons living in the area but not employed in the factory and only slightly greater incidence of mottled teeth in school children.

285. Lapple, C.A.: Dust and mist collection. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 9, 1951, 26 pp.

The use of existing types of dust- and mist-collection equipment is explained and the factors that must be considered in the design and operation of such equipment are summarized. Various types are described. Dust- and mist-collection equipment is required to collect a powdered product; to recover a valuable product; to eliminate a nuisance, to reduce equipment maintenance; to eliminate a health, fire, explosion or safety hazard; to improve product quality, as in air cleaning in the production of pharmaceutical products and photographic film. (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

286. McDonald, J.C., Drinker, P. and Gordon, J.E.: The epidemiology and social significance of atmospheric smoke pollution. Am. J. Med. Sci. 221:325-42, 1951.

This extensive review of epidemiologic problems discusses urban atmospheric pollution with respect to smoke as an agent of disease, environmental determinants of smoke, smoke and man's environment, smoke and human health and experimental studies. The interrelationship of smoke and physical, biological and social environment is complex. The concentration of smoke is influenced physically by weather and terrain and socially by the degree and nature of industrialization, methods of heating, crowding and population density and means of transport. In its turn, smoke decreases sunlight and has a definite effect on buildings, fabrics and other material objects and on plants; however, little is known of its chronic effects on animals. The acute effects of smog on man are well-defined, but studies of the chronic effects involve many variables. The work done in an attempt to establish a reliable index of pollution in relation to disease and the many experimental studies of the effects, including carcinogenesis, of smoke, soot, SO_2, SO_3 and H_2F_2 on man and animals are critically reviewed. The types of future studies that are needed are indicated. (95 references.)

287. Mills, C.A.: Implications of air pollution in chronic respiratory and cardiac disorders. Trans. Natl. Tuberc. Assoc., 47th Annual Meeting, 1951, pp. 284-9.

A study in Los Angeles revealed that the death rates for cardiac and respiratory diseases were higher during periods of 2 or more smoggy days in succession than during similar periods of clear weather. On September 23, 1949, when the worst smog of 1949 occurred, there were 18 more respiratory and cardiac deaths than the daily average for the September control period, almost an equivalent of Donora's "black Saturday." Over the total period of 60 smoggy days reported, the excess of death from cardiac and respiratory causes was 340 over those for the smog-free days, which is nearly 15% of the total deaths for those diseases. The implication is that the smog irritants so increase respiratory and cardiac difficulties for those already ill from these diseases that "a few of the more acutely sick are pushed through death's door." Whether these oft-repeated minor smog irritations may, through years of exposure, lead to respiratory and cardiac diseases still remains an open question. These results are in accordance with those found in the Donora and Belgium surveys, and emphasize the need of pollution control measures. (Ind. Hyg. Dig. 16:353, 1952.)

288. Stern, A.C. and Greenburg, L.: Air pollution--The status today. Am. J. Public Health 41:27-37, 1951.

This is a general discussion of the many aspects of air pollution, including a brief review of some of the investigations of smog episodes. The following topics are covered: Los Angeles smog, and eye irritation in this area; the Donora smog episode and the report published by the Public Health Service on its investigations of the disaster; defense research projects, significance of recent symposia, relation of air pollution to plant life - SO_2 damage to livestock, other effects on vegetation, effect of air pollution on health, air contamination standards, micrometeorology and air pollution, jet dilution of stack effluents, dilution by turbulent mixing, dust dispersion and prediction of smog, air sampling and analysis, scrubbers, adsorbers and dust collectors, governmental regulation of air pollution, Los Angeles Control District rules and smoke abatement.

289. Dautrebande, L.: Physiological and pharmacological characteristics of liquid aerosols. Physiol. Revs. 32:214-75, 1952.

This is a comprehensive review including production of monodispersed aerosols, pulmonary penetration and retention, the pharmacological and therapeutic applications of liquid aerosols and the applications of aerosols in hygiene: air-sterilization, insecticides and fungicides, dust control and smog protection. It also contains an extensive bibliography, i.e., 641 references, on these subjects.

290. Foulger, J.H.: Public health and air pollution. Am. Ind. Hyg. Assoc. Quart. 13:70-3, 1952.

Studies of chronic exposures to low concentrations of irritant gases, e.g., Cl_2, HCl, SO_2, SO_3, phosgene, $POCl_3$ and PCl_3 and to concentrations of Pb and Be as found in the atmosphere, have not demonstrated lung injury, though acute exposures to these substances have led to great injury. Regret is expressed that the study of industrial hazards has not included any which deal with multiple contamination of the atmosphere and its effects on humans. Combined irritants of themselves could not account for effects such as those found in the Donora and Meuse disasters. Besides pathology, the

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Foulger, J.H. (continued)
aspect of physiology or function must also be considered. The author points out that the two systems of the body that must be functioning adequately for life are the respiratory and the cardiovascular systems. He then discusses the stress theory or the "general adaptation syndrome" in which the living organism, when exposed to any stress, e.g., an impaired heart or respiratory system, combats that stress at once by some change within itself. But, in combatting this particular stress, it becomes less able to resist a second stress, e.g., inhalation of irritant gases. The author proposes that this is what probably occurred in the Meuse and Donora disasters.

291. Fredrick, W.G.: Biological aspects of air pollution. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952: 106-9, 1952.
The biological aspects of air pollution are discussed very generally. Principles upon which a valid investigation of the human biological aspects of air pollution can be based are developed and these are applied to the Detroit-Windsor investigation.

292. Gosline, C.A.: Preface and outline, Air Pollution Abatement Manual, Manufacturing Chemists' Assoc., Inc., 1952, 6 pp.
In recent years much attention has been devoted to the recovery treatment and disposal of wastes discharged into the atmosphere from the operations of business, industry, agriculture and the public. Much reliable data concerning the problems attending thereto have been published in the last several years, but the data have been widely scattered. The Air Pollution Abatement Committee of the Manufacturing Chemists' Association has organized and assembled this manual to accumulate the present knowledge about air pollution under one cover where it can be applied readily to such problems. Outstanding authorities both within and outside the chemical industries have participated in preparing 12 chapters on various phases of the subject. In each separate chapter reliable data from widely scattered sources and the author's own special experience have been presented. It is hoped that this consolidation will benefit planning or work to avoid or correct air pollution problems. Contents of the manual are outlined. (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

293. Jenkins, G.F.: Bibliography. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 12, 1952, 57 pp.
This bibliography contains more than 1,500 references on air pollution, its causes, effects, its control and abatement and many other miscellaneous related subjects. Originally it was proposed to include in the bibliography only fundamental and significant contributions to the problem of air pollution and its control. However, it rapidly became apparent that, owing to its complexity and because of the still great lack of exact scientific knowledge, it was extremely difficult to choose between degrees of usefulness of the references available. As a consequence, it became more important to attempt to include reference to all that has been written on the subject, than to attempt to be selective in a problem which involves human opinion as well as factual science, to such a marked extent. (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

294. Katz, M.: The atmospheric pollution problem in Canada. Chemistry in Can. 4, No.8:25-32, 1952.

The air pollution problems that occurred at Trail, B.C., the Sudbury Ni-Cu smelting area and the Yellowknife area are reviewed. Pollution in urban areas is discussed generally. The results of the international Detroit-Windsor pollution problem are reviewed extensively. The effects of pollution on vegetation are discussed and the results of some experimentation in the field are given. Chronic health effects that have been recognized are eye irritati[illegible] Los Angeles, increase in the death rate from respiratory dise[illegible] fogs in industrial communities as in England and loss of su[illegible] and decrease in UV irradiation. The Donora report stressed the significance of synergistic effects from air pollution. Since there is practically no previous experience on which to base measurement of the chronic effects of exposure to air pollution, the biological studies in the Detroit-Windsor area will be carried out in 2 stages: a fact-finding study to assess the problem and then a full scale epidemiological sample survey of sickness or health in the Detroit-Windsor area and in control cities. Control measures and emission standards are also discussed. (67 references.)

295. Kehoe, R.A.: Effects of industrial atmosphere on workmen and on community. Heating, Piping, Air Conditioning 24, No.5: 122-5, 1952.

The professional relationship of the physician and the engineer in this study is defined. It is the function of the physician and medical investigator to discover and define the limits of physical and chemical stress to which the human organism may be subjected with safety and benefit, while it is the function of the engineer to find the means of controlling the physical and chemical factors within the limits defined. It is commonly, but erroneously believed that because a substance or type of energy is harmful in adequate concentration or dosage, it must be somewhat harmful in minimal concentration or dosage. Toxicity, however, is not a property of substance, but rather a matter of dose or concentration of a substance. The various types of natural, nonindustrial and industrial pollutants are listed. The psychic or esthetic effects of air pollution include disagreeable or nauseous odors, dirtiness and dinginess of person, clothing and general surroundings outside and inside dwellings and public and private buildings and loss of sunshine. Definite discomfort of the body is also an undesirable effect. No adequate evidence has, as yet, shown that chronic human disease has resulted from general atmospheric pollution of industrial cities. However, a type of conviction that stems from a great weight of unsubstantiated opinion has resulted; this increasing body of professional and public opinion cannot and should not be ignored. MAC's, developed for use in industrial exposure, cannot be applied to community exposures because (1) these standards relate to the 1/3 of a day and the 5/7 of the week spent at work and not the full week of 24-hour days; (2) the industrial population is a selected group of adults, and does not include the more vulnerable children, aged and infirm and (3) no precise information is available on the combination of effects of a large number of substances, each occurring in a low concentration in the air. From the engineering approach, the control of gases, vapors, fumes and dusts within the working areas of an industrial plant is much simpler in principle and in practice than that of controlling an outdoor atmosphere. It will be necessary that the investigation of the hygienic effects of atmospheric pollution proceed along the

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Kehoe, R.A. (continued)
following lines: (1) the determination of the composition of the atmosphere of representative industrial communities under a wide variety of conditions; (2) the establishment of the effects of the exposure of experimental animals to known concentrations and combinations of concentrations of a wide variety of pollutants and (3) the study of large and representative segments of populations exposed to known conditions by the methods of epidemiology, augmented, where [illegible] and feasible, by detailed clinical and physiological study [illegible]ted individuals.

296. Kehoe, R.A.: Health aspects of air pollution. Proc. 45th Annual Meeting, Air Pollution and Smoke Prevention Assoc. Am., Inc., Cleveland, O., June 9-12, 1952:125-9, 1952.
Air pollution as a nuisance causes dirty cities, obscures the sunlight and causes stinging of eyes, nose and throat in some areas. It has also caused several notable cases of acute toxic effects. However, its chronic effects are less demonstrable. Though many attempts have been made to correlate the incidence of pulmonary cancer, bronchitis and pneumonia with air pollution, there is little definite evidence to prove it. The toxicity studies in the field of Industrial Hygiene are helpful in indicating the harmful contaminants, but the results cannot be applied quantitatively. The problem is that of guiding legislation and providing the means of control of the hazards in the light of the information obtainable by medical research.

297. Larson, G.P.: Medical research and control in air pollution. Am. J. Public Health 42:549-56, 1952.
Whether medical research or control programs should be pursued in the effort to abate air pollution in Los Angeles County is discussed by the director of the Air Pollution Control District, County of Los Angeles. Much work on the latter has been done. Peak measurements have been obtained for the various liquids and solids and gases and vapors that have been identified in the Los Angeles area; these are given. Various instruments that have been developed for the collection of samples are discussed. Many sources of air pollution in industry, viz., emission of dust, SO_2, odors and smoke particles, are being adequately controlled, and a corresponding drop in the concentrations of these substances in the atmosphere has been noted. However, control of oxides of N, unsaturated hydrocarbons, smoke and fly ash from domestic incinerators are not, at present, adequately controlled. There are growing indications that medical research will be undertaken, but in the meantime, control programs will provide invaluable information and techniques needed by medical researchers.

298. Manufacturing Chemists' Association, Air Pollution Abatement Committee, Subcommittee on Legislation Principles: A Rational Approach to Air Pollution Legislation, Washington, D.C., Manufacturing Chemists' Association, Inc., 1952, 23 pp.
This pamphlet formulates a framework within which a proper bill for a control law can be written if needed. The fundamental precepts and organization for such a law are discussed.

299. McCabe, L., Chairman: Air Pollution. Proc. United States Technical Conference on Air Pollution. N.Y., McGraw-Hill Book Co., Inc., 1952, 847 pp.
The 97 papers of this conference were presented at the following panels: agricultural, analytical methods and properties, equipment, health, instrumentation, legislation and meteorology. The following

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McCabe, L. (continued)

14 papers were given at the health panel.

Townsend, J.G.: Short-range exposure to high concentrations by air pollutants, pp. 451-4.

The Meuse Valley and Donora episodes and the smog situation in Los Angeles are reviewed. Other aspects of air pollution discussed are possible effects of Mn, Be and "inert" dusts, incidence of cancer, effects on oral structures, aggravation of acute infectious respiratory diseases, loss of sunlight and possible allergic ef[illegible].

Ashe, W.F.: Acute effects of air pollution in Donora, Pe[illegible]ylva[illegible], pp. 455-61.

The findings of the U.S. Public Health Service on the Donora smog episode, which coincided with those of the Kettering Laboratory, are discussed.

Sulzberger, M.B.: Skin effects of air pollutants, pp. 462-7.

A list of substances absorbable by the skin and a few examples of important skin diseases are given. Skin function and how outside conditions affect the skin are discussed.

Tabershaw, I.R.: Chemically active air pollutants, pp. 468-73.

Evaluation of the toxicity of any chemical is discussed, and the occurrence of some cases of occupational and community Be poisoning is reviewed.

Kehoe, R.A.: Effects of prolonged exposure to air pollutants, pp. 474-8.

The etiology of air pollution from both a natural and artificial origin and topographical and meteorological factors are discussed. Clinical effects of air pollution are assessed.

Hueper, W.C.: Environmental cancer hazards caused by industrial air pollution, pp. 479-84.

Possible carcinogenic agents, routes of entry into the body and future control are discussed. A table of the agent, type of contact and site of cancer is included.

Vorwald, A.J.: Effects of "inert" dusts in air pollution, pp.485-8.

Although a substance may be inherently inert, its physical and chemical character may be altered upon inhalation to initiate reaction or its mere presence may alter the function of the lung.

Wolman, A.: Effects ionizing radiation in air pollution, pp. 489-92.

The prevention of pollution of the air with the radioactive waste products from operation of the U.S. atomic energy program is discussed. The best estimate of maximum permissible limits for human exposure to A^{41}, I^{131}, C^{14} and Xe^{133} is given.

Herrington, L.P.: Neglected areas of investigation in the problem of chemically contaminated fogs, pp. 493-8.

More understanding of the chronic phase of air pollution would be obtained from research into the following 3 problems: (1) more systematic analysis of the basic physiology of long-continued, low-grade chemical insult, particularly in the respiratory system; (2) an answer to the question of cumulative or associative effects from from chemical insults and (3) a better and more complete description of the reactions of chemically polluted suspensions of liquid condensates in fog and smoke. Each of these is discussed.

Blum, H.F.: Effect of loss of sunlight on human health, pp. 499-502.

The following effects of loss of sunlight because of air pollution are discussed: inactivation of vitamin D in human skin, reduction of sunburn, possible effects on the incidence of skin cancer and of the

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McCabe, L. (continued)
common cold, psychological effects and bactericidal effect.
Dunning, J.M.: Effects on oral structures from air pollution, pp. 503-6.
Of the 42 etiological agents that produce effects upon oral structures, F is the only important one in general air pollution. Examples of such pollution are given. Local air pollution, in industry particularly, associated with close contact with these agents is also discu[illegible]
Do[illegible]H.F.: Statistical study of the acute effects of air pollution, pp. 507-11.
In this discussion of the measurement of the relationship of air pollution to health by statistical studies of morbidity, it is emphasized that it is necessary to have reliable measures of morbidity before an attempt is made to attribute ill health to a specific cause, e.g., air pollution.
Baetjer, A.M.: Effect of chronic exposure of air pollutants on acute infectious respiratory diseases, pp. 512-9.
In this discussion examples of individual and experimental data are cited in relation to the more common atmospheric pollutants, e.g., dusts, irritant gases, CO and other compounds. No definite evidence that chronic exposures to low concentrations of chemical contaminants affect susceptibility to acute respiratory infections has been obtained.
Wittich, F.W.: Respiratory tract allergic effects from chemical air pollution, pp. 520-8.
The allergens discussed in this paper include smuts, haptens and insecticides. These may cause asthma, rhinitis or an eczematous dermatitis. Asthma has also been initiated by a number of other miscellaneous allergens.

300. Meetham, A.R.: Atmospheric Pollution--Its Origin and Prevention. London, Pergamon Press, Ltd., 1952, 268 pp.

The following topics are discussed in this book: origin of fuel, natural fuels, artificial fuels, industrial boilers, power and electricity, industrial furnaces, domestic fires, atmospheric pollution, measurement of atmospheric pollution, distribution of pollution, changes in pollution, effects of pollution, prevention of atmospheric pollution and the law and its administration.

In the chapter on atmospheric pollution, the approximate constitution of the atmosphere at 10 C. and normal pressure is given under the divisions of major and minor constituents and impurities. The maximum allowable concentrations, in mg./m.^{3}, for prolonged exposure, and concentrations in town and in country on both hazy winter days and in summer are given, though incompletely, for the impurities, viz., SO_2, combustible solid and liquid particles, incombustible solids, CO, SO_3, NH_3, HCl, H_2F_2 and H_2S. Very generally, concentrations on a hazy winter day are ca. 5 times those in summer and the maximum allowable concentrations are 10-20 times those on a hazy winter day. The individual pollutants of smoke, ash, SO_2, other pollutants from the combustion of fuels, gases from chemical works and from offensive trades and particles are discussed.

The distribution of the various impurities throughout England is discussed. Insoluble solids were found to vary greatly with the density of industry, the pollution being 2-3 times heavier at the center of industry than in the rest of town, and town pollution being ca. 10 times heavier than in the country. Soluble solids,

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Meetham, A.R. (continued)
however, were only ca. twice as concentrated in town as in rural areas. These latter are more easily carried by the wind, and some of them may even come from evaporation of the sea. Changes in both deposited and suspended air pollutants are effected by human activity and the weather. The various aspects of these 2 factors, e.g., the yearly, weekly and daily cycles, wind direction, rainfall, temperature, wind speed and turbulence, are discussed.

The effects of air pollution on human health, animals, plants and material things are generally discussed. "With the evidence at present available, it is not always possible to distinguish clearly between the effects on health of different forms of atmospheric pollution." The wide differences between the death rates in towns where there are similar concentrations of smoke suggest that one cause of cancer of the respiratory system must be some particular compound which is found in varying amounts in smokes from different coals. A study of 100 healthy factory workers exposed to 30 ppm SO_2 during working hours was made in 1932. A significant increase in the incidence of nasopharyngitis and other symptoms of the respiratory tract, abnormal urinary acidity, a tendency to increased fatigue, shortness of breath and abnormal reflexes were noted in the test group as compared to the control group. There was no significant change in the incidence of colds, but their duration was increased in the test group. Smoke and gaseous pollutants reach their highest concentrations during foggy weather, and visibility and sunlight are decreased considerably.

301. Meyer, W.: Zum Auftreten von Dentalfluorose in Deutschland. (Occurrence of dental fluorosis in Germany.) Deut. Stomatol. 2:251-3, 1952.

Attention is called to the report by Hoffmann-Axthelm and Wohins on the occurrence of dental fluorosis in Saxony. This report is discussed on the basis that other factors besides the F content of drinking water contribute to the existence of this anomaly, such as nutrition and F content in general diet. The region in question is in the neighborhood of the Dohna F plant; the effluents deposit on vegetation and increase the F content of vegetables, fruit, flour, etc. Use of F-containing fertilizers in the spring also may contribute to the increase in the F content of ground waters. The advisability of removing F from drinking water is discussed.

302. Schrenk, H.H.: A scientist views the air pollution problem. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952: 24-7, 1952.

The air pollution problem is discussed generally with respect to health effects, other factors related to effects, the causes of air pollution, interpretation of analytical results and reduction of air pollution. The need for further research on the effects of air pollution on health, on better sampling and analytical procedures and equipment, on more efficient and economical control equipment and on meteorological aspects, and for team-work between the scientist, the public and industry is stressed.

303. Seamans, F.L.: Legislative requirements. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 4, 1952, 20 pp.

In any consideration of legislative requirements, one fundamental principle must be clearly recognized, i.e., that responsibility for enforcement is legitimately that of a governmental agency, but responsibility for performance must be that of the individual or

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Seamans, F.L. (continued)
company involved. This chapter discusses the fundamental principles of sound air pollution legislation and analyzes existing legislation. (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

304. Silverman, L.: Air cleaning investigations. In: Sanitary Engineering Conference held at South District Filtration Plant, City of Chicago, U.S. Atomic Energy Commission, 1952, pp. 72-9.
[illegible] basic objectives of the Harvard program on air and gas cleanin[illegible] devices and problems sponsored by the U.S. Atomic Energy Commission are described briefly, and the progress made in each of these phases is reported. Three items in the research and developments phase, viz., study of the performance of wet cell washers, development of a filter with extended life and development of a mechanical electrostatic filter, are further discussed.

305. Clemo, G.R.: A suggestion and some consequences. Some reflections on Liebig's call to British Chemists at the Liverpool Meeting in 1837, together with observations on the nature of city smoke. Chemistry & Industry 1953:957-64.
A historical review of the development of chemistry, organic in particular, is presented in this Presidential Address to Section "B" of the British Association at Liverpool. A brief account is given of the isolation of 3 fractions A, B and C (each a mixture) from city smoke.

306. Doyle, H.N.: Polluted air, a growing community problem. Public Health Repts. (U.S.) 68:858-67, 1953.
The interest of the public and communities in air pollution has been increasing. The author points out that a certain degree of air pollution will have to be tolerated. Many studies of the correlation of respiratory and chronic diseases and of lung cancer with increased severity of pollution have been attempted, but these have not been able to establish definite proof. Acute effects of air pollution have been definitely experienced under certain combined topographical and meteorological conditions; several of these incidents are briefly reviewed. Eye and nose irritation, though not injurious to health, are further discomforts of air pollution. There is definite evidence of the toxic effects of pollutants on animals and vegetation; F^-'s and SO_2 have been identified as the 2 main toxic pollutants. Economic damage in the U.S. from air pollution is estimated at $1.5 billion, and valuable natural resources are daily being lost in stack emissions. In the analysis of the atmospheres of Detroit, Windsor (Ontario) and Charleston, W.Va., Fe, Ca, Mg and Si were found to constitute 80-90% of the bulk of the metallic elements. This qualitative pattern of the inorganic pollutants appears to be remarkably similar in large industrial areas which have climatic and industrial resemblances. Concentrations of certain elements in the atmospheres of Detroit and Cincinnati are compared according to residential, semi-industrial and industrial districts. Contaminants are largely organic in nature, but insufficient information is available on the organic constituents to conclude that there is a similarity in the organic contaminants in industrial areas. The degree of pollution in any area is affected by seasonal and meteorologic variations.

There is no legislation on the Federal level, but the U.S. Public Health Service has undertaken air pollution investigation. Many

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Doyle, H.N. (continued)
states and local governments have set up air pollution programs under their industrial hygiene agencies. The Pa., Md., N.J., W.Va. and Ore. state programs are reviewed. The various private agencies active in this field are also mentioned. The mutual responsibilities of the public, government and industry in the problem are discussed.

307. Falk, L.L.: Evaluation of data. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 11, 1953, 24 pp.
"It is not the purpose of this section to state what analyses or tests are to be made for the solution of a given problem, but it must be pointed out that the objectives of a study are paramount in determining what information is needed to reach them. A clear statement of goal may frequently result in considerable saving of effort. Also, careful examination of the goal may show that original tests or analyses considered desirable are inadequate to permit a definite conclusion or, perhaps, provide entirely irrelevant information. The interpretation of data is most often based on experience. In the case of municipal or similar air pollution surveys, for example, comparisons with findings of workers in other localities provide bases of comparison. In another instance, where design of fly ash collectors for a powerhouse stack is anticipated, representative samples of the existing ash must be obtained and its particle size distribution carefully determined and statistically evaluated. The selected design is then based on previous experience of the types of equipment best suited economically, as well as technically, to collect the type of ash under consideration." (25 references are cited.)

308. Helmers, E.N.: The meteorology of air pollution. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 8, 1953, 40 pp.
For a given situation, severity of air pollution is determined largely by the weather. Even though the total discharge of contaminants to the atmosphere in a given area remains constant from day to day, the degree of air pollution will vary widely. The observation that smoke is dissipated much more quickly and thoroughly on some days than on others is the direct result of differences in the weather. Quantitative means for evaluating these weather effects are necessary to insure satisfactory and economically optimum solutions to atmospheric pollution problems. The following topics are discussed: fundamentals of meteorology, atmospheric diffusion, stack meteorology, planning and interpreting air pollution surveys, site selection and air pollution climatology and meteorological control. (68 references are cited.)

309. Jenny, R.J.: Gas and vapor abatement. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 10, 1953, 29 pp.
The purpose of this chapter is to describe proved methods of reducing atmospheric pollution contributed by gases and vapors. The chapter summarizes the factors to be considered and equipment required for the methods of waste dispersal, absorption and scrubbing, incineration, catalytic combustion and adsorption. (18 references are cited.)

310. Magill, P.L. and Littman, F.E.: Air Pollution in Los Angeles. Paper presented at the Annual Meeting of the Am. Soc. Mech. Eng., Nov. 29 - Dec. 4, 1953, New York, 1953, 31 pp.

Some of the more significant scientific events that resulted from study of the smog problem are related from a historical viewpoint. The topography and meteorology of the area was studied. Occurrence of eye irritation and damage to crops was related to the occurrence of smog, and an objective method for forecasting the latter was developed. Measurements and tests were made on smoggy days to determine the smog constituents; at least 50 different substances have been identified. The methods of collection and of analysis, both qualitative and quantitative, and the maximum concentrations and those found on a typically smoggy day are tabulated. High O_3 concentrations, 30-40 pphm, were measured in the area, and these peak concentrations coincided with peak smog effects. It has been concluded that O_3 is formed by the action of sunlight on some as yet unidentified atmospheric impurities. Damage to plants resembling smog damage was obtained by fumigation with reaction products of O_3 and unsaturated hydrocarbons. The oxidizing agent begins to form simultaneously throughout the entire Los Angeles Basin, at desert locations and at points as far N as Santa Barbara, with crop damage occurring at concentrations $\geq$15pphm and eye irritation, $\geq$20 pphm. Reduction of visibility is caused by a variety of solid and liquid particulate matter in the air, with the latter predominating. The sources of pollution are combustion of fuel by the general public, the petroleum industry and other industries, automobile exhausts and evaporation of hydrocarbons from petroleum production, marketing and refining. The total daily amounts of materials burned and the estimated tons of individual pollutants emitted daily from the various sources are tabulated. Progress has been made in pollution control, but the constant expansion of industry and population have made the reduction unobservable. The problems remaining to be solved are the control of automobile exhaust and backyard incinerators, the origin of O_3, possibly undetectable eye irritants and the effect of smog on health in Los Angeles. More research is necessary, and valid clues to control must be acted upon even while research is in progress. (36 references.)

311. National Smoke Abatement Society (London): The London fog, December, 1952. A first survey. Smokeless Air 23, No.85:100-11, 1953.

This is a first survey of the London disaster. The concise discussion includes the weather factors, the pollution in the fog, the deaths, illness, animal health, plant life and economic costs. 5 tables and 6 graphs illustrate the data well. For final reports see:

Wilkins, E.T.: Air pollution and the London fog of December, 1952. J. Roy. Sanit. Inst. 74:1-15, 1954.

Ministry of Health: Mortality and Morbidity During the London Fog of December, 1952, Report by a Committee of Departmental Officers and Expert Advisers appointed by the Minister of Health. Reports on Public Health and Medical Subjects, No. 95, H. M. Stationery Office, 1954, 61 pp.

Committee on Air Pollution: Report, Presented to Parliament by the Minister of Housing and Local Government, the Secretary of State for Scotland and the Minister of Fuel and Power by Command of Her Majesty, London, H. M. Stationery Office, 1954, 80 pp.

312. Phair, J.J.: Air pollution and human tolerance. Modern Sanitation. 5, No.8: 61-4, No.9:61-6, 1953.

For abstract, see

Phair, J.J.: The epidemiology of air pollution. In: Magill, P.L., Holden, F.R. and Ackley, C. ed.: Air Pollution Handbook. N.Y., McGraw Hill Book Co., Inc., 1956.

313. Regan, C.J.: Air pollution. Chemistry & Industry 47:1238-44, 1953.

Air pollution has been a problem since Biblical times and its nuisance has been recognized in England since the Middle Ages. The main sources of air pollution are smoke, ash and grit and S oxides from the combustion of fuels, of which over 205 million tons were burned in 1951 in England, and other industrial emissions in limited areas. The chief instruments used in measuring air pollution are the deposit gauge, PbO_2 cylinder, volumetric SO_2 apparatus and smoke filter. The effects of air pollution are classified as (a) corrosion and damage to buildings, fabrics, etc., (b) damage to health, (c) damage to agriculture, (d) dirt and nuisance and (e) waste of fuel. The latter 3 are briefly discussed. Damage may not only be caused by a concentration of SO_2 by adsorption on particulate matter, but also by H_2SO_4 formed by catalytic surface oxidation of SO_2 to SO_3 on the particles and subsequent combination with H_2O. The effect of this acid atmosphere on metals and on limestone and dolomite buildings is very pronounced. The acute effects on health from the well-known smog disasters are briefly reviewed. Chronically, deprivation of sunlight by air pollution tends to produce rickets in children, and particles of smoke with S acids and SO_2 itself are known lung irritants. Benzpyrene, present in bituminous coal smoke, is a known carcinogen. A further possible chronic effect is mentioned. Plants subjected to polluted air for only part of the 24-hour day, grow at a higher rate than those exposed to only pure air. This is explained by Bleasdale (Brit. Med. J. 2:1045, 1952) by the fact that the partially oxidized S radicals present in polluted air inhibit cell division; but after short exposures, the concentration of these substances may be quickly decreased, while the sulfhydryl compounds, also present in polluted air, will be free to stimulate growth. It is suggested that this effect in plants may have some relation to the abnormal growth of bronchial epithelium which occurs in lung cancer. Also, derivatives of H_2SO_4 have been shown to inhibit certain respiratory enzyme systems. Exhaust fumes contribute many contaminants to the air. The effects of toxic constituents on health show a geometrical progression, rather than merely summation. Several suggestions for an abatement program, similar to those made by the Beaver Committee, are made.

314. Scott, J.A.: Fog and deaths in London, December 1952. Public Health Repts. (U.S.) 68:474-9, 1953.

In this review of the London fog of Dec. 1952, the daily concentration of smoke and SO_2 at London County Hall from Nov.16-Dec.27, 1952 are tabulated and graphed. Both show peak concentrations on Dec. 7 and 8 of 4.46 mg./m.^{3} smoke and 1.339 ppm SO_2, as compared with the summer (June) average concentrations of 0.12 mg./m.^{3} smoke and 0.07 ppm SO_2. The mean daily temperature was also recorded; a striking drop from the 80-year average is noted for the period, Dec.5-8. The number of registered deaths in London increased sharply from 945 for the week ending Dec.6 to 2,484 for the week ending Dec.13; the number remained high (1,029-1,523) for the following 4 weeks ending Jan.10,1953. The increase in death rates was greater than that for the fog of 1873 or for the cholera epidemic of 1866. The deaths in the 6 weeks ending Dec.27, 1952 are classified by age and the latter 3 weeks are compared with the average of the 1st 3 weeks. A 3-fold increase in deaths is shown for the 4th week (Dec.7-13) for babies 4-52 weeks and for adults >55 and approximately a 2-fold increase for all other ages. The deaths are also classified by cause for each week in a similar manner as for age. Causes

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Scott, J.A. (continued)
of death were almost entirely disorders of the circulatory and respiratory systems. Deaths from bronchitis for the week ending Dec.13 were 10 times as many as those for the previous 3 weeks; from pulmonary t.b., $4^1/2$ times as many; from other respiratory diseases, 6 times as many; from lung cancer, 2 times as many and from disorders of the heart and circulatory system, 3 times as many. In the fog of 1873, greater mortality from respiratory and circulatory disorders and among the very young and old also occurred. Similarly, animals in the Smithfield cattle show became ill and some died during both fogs.

315. Stokinger, H.E.: Toxicologic perspective in planning air pollution studies. Am. J. Public Health 43:742-51, 1953.
This discussion is a critical evaluation of past studies of acute and chronic air pollution incidents and of current investigations, and it presents toxicologic information pertinent to the planning of such studies. Reports of the acute disasters of the Meuse Valley and Donora did not reveal any single contaminant as responsible, but rather a combination of 2 or more. SO_2, however, was held the most suspect. The contaminants were below known toxic levels. The people affected were in the older age group and/or afflicted with heart disease, bronchial asthma or chronic bronchitis, or pulmonary emphysema, and these would be more sensitive to slight changes of air composition. The effects of combinations of irritant gases plus other agents or the adsorption of such gases on particulate material has also been found important in smog. Chronic incidents included 16 cases of Be poisoning occurring in the vicinity of a Be plant. According to the best estimates, the Be levels in the atmosphere were of the order of 0.01-0.1 μg./m.^{3} air which demonstrated that chronic poisoning can occur from such low concentrations. Analysis of the concentrations of 20 metallic elements in the urban atmosphere of 3 cities showed a good uniformity of results among the 3 cities, except for an occasional variation, and indicated a total metallic load of 0.2-0.5 mg./m.^{3} emitted in the present state of industrialization. Analysis of country air around Cincinnati showed that no element that was present in the city was absent in the country air. Particle size and chemical combining power are also important determinants of pollutants' effects. Organic constituents in smog are responsible for eye irritation. Dixon's theory of how these eye irritants act is reviewed. The possible acute or chronic toxicologic reactions of SO_2, H_2F_2 and F_2, H_2S, NO_2 and As and AsH_3 are reviewed. The principal considerations in planning a medical study are discussed. There are at least 5 independent and 16 dependent variables in the response of individuals besides those in smog itself. These have to be reduced to an absolute minimum in any health study for any reasonable chance of success.

316. Stokinger, H.E.: Toxicology of chemical air pollutants. Chemistry in Can. 5:23-6, 36, 1953.
This is a review of the biological fate of air pollutants. Factors affecting bodily intake, deposition and retention of particles and gases are briefly discussed. The absorption, distribution and excretion of inorganic and organic substances are reviewed in general, and the toxicology of SO_2, SO_3, H_2SO_4, H_2S, As, AsH_3, Be, Cd, F and its compounds and some of the metals is reviewed in particular.

317. Allcut, E.A.: Air pollution control in Canada. Eng. J. 37:249-53, 1954.
The general picture of the Canadian situation is considered, followed by an analysis of the by-laws pertaining thereto. These are summarized in table form. The activities of the smoke abatement authorities in Toronto from 1950-53 are tabulated with respect to inspections, court proceedings and applications for installation permits. Convictions of 80-90% of the number of summonses issued are reported to have been obtained. Special cases are then briefly described, including SO_2 pollution in Trail, Sudbury and Detroit-Windsor. The work of the International Joint Commission is briefly described,and a summary is given of the As_2O_3 investigation at Yellowknife. Smoke from railways and steamships and danger from radioactive emissions are also discussed.

318. American Society for Testing Materials: Symposium on Odor. Presented at the 57th Annual Meeting, Chicago, Ill., June 15, 1954, ASTM Spec. Tech. Pub. No. 164, 1954, 81 pp.
The following papers appeared in the symposium:
Sagarin, E.: Odor: a proposal for some basic definitions, pp. 3-8.
Ruff, R.J.: Catalytic method of measuring hydrocarbon concentrations in industrial exhaust fumes, pp. 13-21.
Deininger, N. and McKinley, R.W.: The design, construction, and use of an odor test room, pp. 23-30.
Gee, A.H.: Organoleptic appraisal of three-component mixtures, pp. 33-53.
Gruber, C.W.: Odor pollution from an official's viewpoint, pp. 56-65.
Turk, A.: Odor control methods: a critical review, pp. 69-80.
Discussions follow each of the papers. The last 2 papers have been abstracted under separate title.

319. Anonymous: Babies died during smog. Los Angeles News 11/28. Smog News No. 32:12, 1954.
The death of 3 babies, alleged to have been officially linked with smog, and whose parents are considering lawsuits as a result, is reported in this news item. "Microscopic tests are being conducted by the coroner's office to determine how great a factor smog was in the aggravation of the respiratory inflammation which caused the deaths. After autopsies had been performed on the children, Chief County Autopsy Surgeon Dr. Frederick Newbarr said: 'Smog irritants are of such a nature that in my opinion they could readily make worse pre-existing inflammatory processes of the respiratory tract.'"

320. Anonymous: Causes trouble in schoolrooms. Los Angeles Times 10/16/54. Smog News No.29:6, 1954.
"The smog was causing trouble in classrooms throughout the city yesterday. School headquarters reported widespread complaints by children unable to concentrate because of watering eyes and burning nostrils. Teachers were having difficulty keeping order among youngsters made restless and irritable by the atmospheric conditions, school officials reported, following a spot check of 100 schools in the south, central and Hollywood areas."

321. Anonymous: Harmful to health. Pasadena (Cal.) Star. Smog News No.17:4, 1954.

"Most members of the Los Angeles County Medical Association are convinced that smog has an injurious effect on their patients' health, Dr. Francis M. Pottenger, Jr. told members of the Pasadena Junior Chamber of Commerce. Of 3803 doctors who responded to the poll only 242 said they found no ill effects from smog or expressed no opinion, he said. Of these 242, it was found that 104 reside outside the smog area and many others were retired from active practice, he said. Of the total, 2008 found smog injurious to eyes, and others found it affected the nose or lungs, he added."

322. Anonymous: Low-concentration smog deaths. Mortality rate high among older people and those with cardiac and respiratory defects. Chem. Eng. News 32, No.13:1268-9, 1954.

This is a summary of the paper given by Mary O. Amdur of Harvard University School of Public Health at a symposium on air pollution and its control, held at Wagner College on Staten Island, N. Y. in March, 1954. The paper was also briefed in Public Health Reports. For the abstract, see Amdur, M.O.: Toxicological studies. In: Ingram, W.T., Amdur, M.O., Munroe, W.A. and Minasian, G.T.: Symposium on air pollution. Public Health Repts. (U.S.) 69:721-9, 1954.

323. Anonymous: Recovers from California smog. Casper, Wyoming Tribute-Herald 10/26. Smog News No.30:5, 1954.

The illness of a Pasadena, Calif. woman "recuperating from the devastating effects of smog in her home city" is reported. The woman has been under an oxygen tent trying to get relief from bronchial trouble induced by the smog. A resident of Pasadena for 15 years, the woman said that the smog situation there has been getting progressively worse. It was so bad this year, she said, that she was unable to breathe at times."

324. Anonymous: Smog scramble spans nation. Chem. Eng. News 32:1108-13, 1954.

The problem of air pollution throughout the U.S. and London and the progress towards its control are reviewed. What has been done and what needs to be done by local legislation and by industry in the following areas are discussed in particular: the New York area, Chicago, the Detroit-Windsor area, the Houston Ship Canal and along the Gulf Coast, Tennessee, So. Carolina, Birmingham, Ala., Los Angeles, Oregon, Washington and London.

325. Anonymous: Smog seen as factor in death. Los Angeles Times 10/16/54. Smog News No.29:6, 1954.

"Smog probably was a contributing cause of the death of a 10-yr. old Alhambra girl" according to the coroner's autopsy surgeon.

326. Anonymous: Sulfur chief cause of fog deaths. Foreign Letters, J. Am. Med. Assoc. 156:785, 1954.

This is a brief review of the Ministry of Health report. See: Ministry of Health: Mortality and Morbidity During the London Fog of December 1952, Report by a Committee of Departmental Officers and Expert Advisers appointed by the Minister of Health. Reports on Public Health and Medical Subjects, No.95, H.M. Stationery Office, 1954, 61 pp.

327. Barkley, J.F.: Accepted limit values of air pollutants. U.S. Bur. Mines Inform. Circ. 7682, 1954, 6 pp.

The Threshold Limit Values adopted by the American Conference of Governmental Industrial Hygienists and variations, including additions, adopted by certain states are tabulated and discussed. The states that adopted limit values, with the year of adoption, are: California (1949), Colorado (1941), Florida (1947), Kentucky, Massachusetts (1951), Maryland (1944), Michigan (1952), Mississippi (1948), Ohio (1946), New York (1952), S. Carolina, Vermont, Virginia (1952) and W. Virginia (1951). Although these values are based on "confined" or "inside" spaces, "it could be assumed that the values would also be conservative for 'outside' spaces for no longer than an 8-hour period. In the use of such values for the general populace, however, questions arise as to their applicability to the very young, the aged and to those with impaired health." The possibility of synergistic action on simultaneous exposure to several toxic substances must also be considered. From the standpoint of vegetation, no definite limit values have gained general acceptance. "As regards property damage, virtually any concentration of a pollutant, such as H_2SO_4 or H_2S, that will attack materials will do some damage. Since property cannot repair itself like a living organism, it is a question of what can be tolerated. As regards industrial processes, nothing as to limit standards was found either in literature or by personal inquiry."

328. Cholak, J.: Measurement of air pollution. Arch. Ind. Hyg. and Occupational Med. 10:203-9, 1954.

The necessity of detecting and measuring the constituents of the atmosphere, and thus of identifying the agent or agents responsible for irritant or injurious effects, is emphasized. Although many data are are available on certain air pollutants, procedures and equipment are lacking for collecting and analyzing these and many other pollutants during adverse weather conditions. Tables presented in the discussion give the concentrations of common air pollutants in the average urban area and the concentrations of a number of toxic materials in suspended matter, together with the threshold concentrations for several metallic constituents, sulfurous material, nitrates and 3:4-benzpyrene.

329. Clemmesen, J.: Bronchial carcinoma--A pandemic. I. Danish Med. Bull. 1:37-46, 1954.

Nielsen, A. and Clemmesen, J.: Bronchial carcinoma--A pandemic. II. Incidence and tobacco consumption in various countries. Danish Med. Bull. 1:194-9, 1954.

Analysis of data concerning the incidence of bronchogenic carcinoma in Denmark and in several other countries indicates that a further increase of considerable magnitude has to be expected during the next 35 years. The prevention of this expected increase appears to be a problem of great practical importance and urgency. The figures collected in Denmark fail to show a clear-cut correlation between the incidence of bronchogenic carcinoma and air pollution. Data from some other countries do show such a correlation, but close scrutiny indicates that efforts to improve atmospheric conditions can lead, at best, to an insignificant reduction in the number of cases. Various occupational exposures are associated with an increased incidence of bronchogenic cancer. While further research for the elimination of such occupational dangers is, of course,

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Clemmesen, J. et al. (continued)
indicated, the number of cases preventable by such measures appears to be very small in relation to the total problem. Data available show that an increase in the consumption of cigarettes/person in a given country is followed by a corresponding increase in the mortality from cancer of the lung among males approximately 2 decades later. Thus, education of the general public, especially of young people, concerning the danger of the abuse of tobacco appears to be the most important preventive measure available at present. (Abst. Am. Rev. Tuberc. 72:79, 1955).

330. Cooper, R.L., Lindsey, A.J. and Waller, R.E.: The presence of 3:4 benzpyrene in cigarette smoke. Chemistry & Industry 1954:1418.
Anthracene and pyrene, and small quantities of acenaphthylene and 3:4-benzpyrene were found in the neutral fraction of cigarette smoke soluble in cyclohexane. The determinations were made by absorption spectrophotometry and confirmed by fluorescence spectrography. The amount of 3:4-benzpyrene is of the order of 1 μg./100 cigarettes, each weighing ca. 1.1 g. The larger amounts of pyrene and anthracene are measurable with greater accuracy, and the relative proportions of the hydrocarbons are entirely different from those found in atmospheric soot, the anthracene being much higher and the benzpyrene much lower in cigarette smoke. It is estimated that 150 μg. 3:4-benzpyrene would be inhaled/year by a person smoking 40 cigarettes/day, and that 200 μg. would be inhaled over the same period from an average urban atmosphere. This latter benzpyrene is in all probability adsorbed on C particles and may well be relatively inactive. And this inhaled air is partially filtered in the nasal passages during normal breathing and many larger particles never reach the lung. The hydrocarbons in cigarette smoke, however, are dissolved or suspended in tiny droplets of solvent material and any carcinogen present is likely to be more fully active.

331. Dautrebande, L.: Aerosole aus flüssigen Medien. (Aerosols from liquid media.) Z. Aerosol-Forsch. 3, No.2:117-95, 1954.
For abstract, see article published in Physiol. Revs. 32:214-75, 1952.

332. Davenport, S.J. and Morgis, G.G.: Air Pollution. A Bibliography. U.S. Bur. Mines Bull. 537, 1954, 448 pp.
This bibliography contains 3902 abstracts.

333. Editorial: Air pollution. J. Am. Med. Assoc. 156:44, 1954.
The nature of the problem of air pollution, its sources and effects, are discussed. What has been done in pollution control in Los Angeles and Detroit is very briefly reviewed.

334. Editorial (Eckardt, R.E. and Drinker, P.): Experimental lung cancer. Arch. Ind. Hyg. and Occupational Med. 9:449-50, 1954.
This editorial urges that great caution must be exercised in assigning a causative relation between inhaled materials and lung cancer in human beings. Human epidemiologic data supplemented by animal experimentation give the only really sound way of associating human cancer with an environmental exposure. Though skin carcinogenesis in the mouse has been used as an effective guide to the control of potential occupational skin carcinogens in man, the mechanism is by no means completely understood. Lung carcinogenesis

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Editorial (Eckardt, R.E. et al) (continued)
in the mouse is less understood. A study of occupational lung cancers suggests that a completely different set of mechanisms may be at work. It therefore seems highly dangerous to draw conclusions about human lung cancer from experimental evidence based on the presence of mouse skin carcinogens.

335. Geiger, J.C.: Some Public Health Aspects of Lung Cancer. The Possible Relation of Tobacco Smoke and Smog. Oakland, Calif., Department of Public Health, 1954 (?), 24 pp.

After a preliminary discussion of the history of medicine in So. America, the author discusses, in general, lung cancer statistics for 1943-52 for 13 U.S.A. cities, viz., Baltimore, Cincinnati, Cleveland, Dallas, Washington, D.C., Los Angeles, Minneapolis, N.Y. City, Philadelphia, Pittsburgh, St. Louis and Seattle. These are not tabulated, and only the following rates per 100,000 are mentioned.

	1943	1952		1943	1952
New York	--	27.6	Oakland	9.3	20.5
Philadelphia	--	27.0	(greatest increase over 1943)		
Seattle	14.2	23.4	Dallas	9.5	19.5

More men have died from this disease than women. The present ratio is approximately 5:1 and a tendency for this ratio to increase is noted. In Oakland, the ratio was 3:1 in 1943-47 and 6:1 in 1948-52. Significant increases in their ratios were also noted for Baltimore, Cincinnati, Cleveland, Washington, D.C., Los Angeles and Seattle. It is noted that over the 10-year period there was no increase in the death rate from lung cancer in females over or under 45, nor in males <45, but that the rate increased very rapidly in men >45 years of age as shown by these statistics.

	under 45		over 45	
	1943	1952	1943	1952
women	1.0	.97	19.4	19.9
men	3.6	3.9	86.3	126.4

The rates are also noted to be greater for urban residents than for rural residents. Inadequate diagnostic facilities may be partly responsible for this difference. The theories and investigations on smoking as a direct causative factor of cancer are discussed at great length, but the author comes to no definite conclusions, stating only that no firm evidence is available. Air pollution is also mentioned as a possible causative factor of cancer, and the meteorological situation and the constituents of the smog over Los Angeles County together with the work of Magill, Haagen-Smit and Kotin are reviewed.

336. Hammond, E.C.: Lung cancer and common inhalants. Cancer 7: 1101-8, 1954.

In this article some of the statistical information about lung cancer is reviewed and some factors possibly influencing susceptibility, some of the inhalants under suspicion, evidence from laboratory studies and evidence from statistical epidemiologic studies are discussed. The age-standardized death rate for lung cancer among males has risen from ca. 0.7/100,000 in 1914 to 3.6 in 1930 to 19.5 in 1950; among females it has risen from ca. 0.6 in 1914 - 2.1 in 1930 - 4.3 in 1950. For all other cancer sites the increase in the crude cancer death rates is attributable to the aging population. In a comparison of lung cancer death rates between males

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Hammond, E.C. (continued)

aged 50 in 1920 and those aged 50 in 1950, it is realized that the 2 population groups differ in the hazards to life and health and the general environmental conditions to which they have been exposed before reaching the age of 50. The life expectancy has been increasing and the proportion of deaths owing to various causes has changed markedly with time. Standardized death rates for t.b. dropped from 189/100,000 in 1900 - 22/100,000 in 1950; the rates for pneumonia and influenza dropped 214 - 27 in these 50 years and the rate for lung cancer rose from 1 - 19.5 in this same time. The varying environmental factors for the 2 groups are discussed. Most prominent of these is the tremendous rise in the prevalence of certain inhalants, viz., soot and fumes from oil furnaces, fumes from internal combustion engines, dust from bituminous-surfaced roads and rubber tires and cigarette smoking, in order of increasing prevalence. Cigarette smoking increased the most, from 3 billion/year in 1900 - 98 in 1925-9 - 398 in 1953. Soot and fumes from coal may also be important, though coal consumption has not increased. Though it has been shown that coal soot can cause scrotal cancer in men and cancer at various sites in animals, no one has as yet produced lung cancer in an animal by inhalation of soot or fumes from burning coal. The laboratory evidence is much the same for fumes from oil furnaces and motor-vehicle engines, though the fumes from both are known to contain carcinogenic agents and human beings do inhale such fumes. Little has been reported on the effect of dust from bituminous-surfaced roads which do contain some carcinogenic agents. No one has succeeded in producing epidermoid cancer of the lung experimentally by the inhalation of cigarette smoke, though skin cancer has recently been successfully produced in susceptible mice by applying a mixture of tar and other substances from condensed cigarette smoke. A preliminary report on the lethal effect of tobacco smoke on cultures of β-proteus is also discussed.

337. Hodge, W.W.: Terminology and selected data. In: Manufacturing Chemists' Assoc., Inc.: Air Pollution Abatement Manual, Chap. 2, 1954, 37 pp.

Because of the rapid national growth of interest in air pollution, the literature on the subject has developed so rapidly that much of the terminology is not available in dictionaries. An effort has been made to overcome this in compiling this Chapter of the Air Pollution Abatement Manual. Searches were made through several dictionaries and the results are summarized in Definitions of Terms. About 70 terms are included. Selected physical and chemical data were taken from thoroughly reliable publications and listed. Many data on new compounds are being published regularly in scientific and technological journals. Usually some time elapses before the data are printed in books. A table of conversion factors is included which may be useful in the calculations involved in practical work on the abatement of air pollution. The rapid advances being made by the chemical manufacturing industries indicate that many new compounds and commercial, chemical substances are being produced every year and some of them might become air contaminants unless proper precautions were observed in the manufacturing operations or in the disposal methods applied. An attempt will be made to keep this Chapter up to date by issuing supplemental information and data sheets at selected intervals.

338. Hueper, W.C.: Environmental lung cancer. Ind. Med. Surg. 23:463-7, 1954.

There has been observed in all industrial countries during the last 50 years, a real, marked and progressive increase in the incidence of pulmonary cancer. Since the lung is also an excretory organ, pulmonary cancer might also possibly be produced by agents entering the body through extra respiratory channels; there exists some experimental evidence of this in rats and mice. Three main types of exposure to environmental atmospheric carcinogens are distinguished: general environmental atmospheric exposure to certain aliphatic and polycyclic hydrocarbons, arsenicals and radioactive substances; special and locally restricted atmospheric exposure in the vicinity of industrial plants emitting large amounts of soot or other polycyclic hydrocarbons and also exposure from tobacco smoking; and certain occupational exposures to specific chemical and physical agents. The epidemiological evidence supporting the claim of an excessive liability to cancer of the lung from prolonged exposure to coal tar fumes is reviewed. There is also a mass of confirmatory experimental observations on many species of animals. The epidemiologic evidence cited in favor of the cigarette smoke theory of lung cancer is reviewed; there is little, if any, medical evidence advanced in support of the cigarette theory. In fact, the evidence available for cigarette smoke cancer even upon superficial examination presents several serious defects and inconsistencies; several of these are examined. The nonspecific irritative properties of an atmospheric pollutant do not provide an index of its prospective carcinogenic properties. Similarly, there is no relation between the degree of carcinogenic potency of the various respiratory carcinogens and their relative toxic qualities. The latent period for occupational cancers of the respiratory system ranges about 10-25 yrs. Little is known about the attack rates.

The conclusions reached are that several, if not numerous, atmospheric pollutants are responsible for causing lung cancer; that additive, cumulative and synergistic effects of several pollutants are possible; that all or most of the occupational respiratory cancers found are attributable to a single carcinogen; that the recent alarming increase in male lung cancer is caused by the local and general development of modern industry and its products; that the evidence does favor cigarette smoking as a major factor in causing lung cancer and that the introduction of new atmospheric pollutants of carcinogenic type be discouraged since such pollutants are too hard to control.

339. Hueper, W.C.: Recent developments in environmental cancer. Arch. Pathol. 58:360-99, 475-523, 645-82, 1954.

This is a comprehensive review of environmental cancer under the topics of occupational cancers 25 years ago, recent developments in occupational and environmental cancers, cancers as environmental diseases and environmental cancers and carcinogens. 25 years ago very little was known about cancer and few cases were reported. In the last few years many industries, research groups and state health departments have become interested and active in the study of it. Examination of cancer rates of various sites for populations all over the world indicates environment rather than heredity or race to be the important factor. Regional variations according to industrial, agricultural, mining regions, etc. within a country are found. Cancer rates are related to socioeconomic groups and more particularly

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Hueper, W.C. (continued)
to occupational groups. Large variations in sex ratio for cancer are found depending upon environmental factors. The increasing cancer incidence rates are real. Such factors as more carcinogenic agents in our general environment (air pollution), a large amount of specific industrial and occupational factors and/or enormous increase in cigarette smoking probably operate to a greater or less degree to produce this effect. Environmental cancers and carcinogens are discussed in detail according to A. inorganic chemicals; B. organic chemicals; C. physical agents; D. infectious agents; E. tobacco extractives; F. dietary factors of general type; G. dietary, occupational, cosmetic and medicinal estrogens; H. specific dietary factors; I. miscellaneous potential carcinogens and J. specific aspects of environmental cancers. An extensive bibliography of 1200 references is included.

✓840. Ingram, W.T., Amdur, M.O., Munroe, W.A. and Minasian, G.T.: Symposium on air pollution. Public Health Repts. (U.S.) 69:721-9, 1954.

The symposium was sponsored by the Department of Bacteriology and Public Health of Wagner College, Staten Island, N.Y., in cooperation with the borough president's Committee for Air Pollution Abatement, in March, 1954. N. Colosi summarized the air pollution problem faced by Staten Island and vicinity. E. Davendorf and A. Rihm described the efforts of N.Y. and N.J. officials to initiate an interstate study of air pollution. Bills giving jurisdiction and adequate funds to the Interstate Sanitation Commission (N.Y., N.J. and Conn.) to make the study have been introduced into the N.Y. and N.J. legislatures this year. P.H. Goodell discussed the function of catalysts in fume combustion, which assist in the oxidation of hydrocarbons and organic gases to CO_2 and H_2O, as an air pollution control measure for some types of manufacturing processes. The catalysts, however, are rapidly deteriorated by fumes containing large amounts of cinders, inorganic solids or vaporized metals.

Ingram, W.T.: An engineering job.

The discovery of the offending air pollutants in a particular locality and their source requires engineering investigation and analysis which take time. The information needed for an industrial survey is summarized. The engineer must be able to observe and record the facts about processes and process operations that will allow him to design workable air cleaning devices. The job requires competence and good judgment.

Amdur, M.O.: Toxicological studies.

In the acute air pollution episodes concentrations of pollutants, while higher than normal, were not excessively high, i.e., did not even approximate MAC values. However, the people affected were highly susceptible persons, and not normal healthy workers for whose protection MAC values were established. Further, it has been proved that workers constantly exposed to some contaminant develop a tolerance to it. Also in such episodes special atmospheric conditions prevail in which interaction among the various pollutants is possible. Very little is known about the chemistry, physics and physiologic effects of such reactions. The carefully controlled studies required to obtain this information will take time. Such work has been done in assessing Los Angeles atmosphere for the causes of eye irritation and plant injury and has yielded definite results. The Army Chemical Center has demonstrated the effect of physiologically inert aerosols in the toxicity of irritant gases.

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Ingram, W.T. et al (continued)
The investigations on the physiologic effects of the S compourds, SO_2 and H_2SO_4 mist, on guinea pigs and man, done at Harvard, are briefly described.

For Munroe, W.A. and Minasian, G.T., see separate abstracts under:-
Munroe, W.A.: New Jersey State Department of Health Program, (1954) and Minasian, G.T.: Contributions of Industry to Air Pollution Control, (1954).

341. Isaac, P.C.G.: The effects, measurement, and control of the atmospheric pollution due to combustion. A review and a bibliography. University of Durham, King's College, Dept. of Civil Engineering, Bull. No. 3, 1954, 32 pp.

Of the 3 types of air pollutants - gaseous effluents from atomic energy plants, toxic gases or dusts produced by industrial processes and products of combustion, the last is considered the most important. A table shows the amounts of atmospheric pollution dissolved in the urban area and of suspended atmospheric pollution in the same area, both smoke and SO_2, for 1949-53 in various cities. The studies of the effects of air pollution on health in the 1952 fog, the studies of Amdur, et al. and some cancer studies, are briefly reviewed. The other effects of smoke, the cost of smoke, measurement of air pollution, variations in atmospheric pollution, meteorology and atmospheric pollution, efficient combustion and flue-gas cleaning are also briefly reviewed. An extensive bibliography of 176 references is given.

342. Josie, G.P.: Public health statistics in air pollution studies. Can. J. Public Health 45:64-9, 1954.

The usual public health statistics, especially mortality rates, school health records and medical care plan records should be considered, but are apt to be of limited usefulness in air pollution studies. The most feasible experiment is the study of population groups in the same community matched as to socioeconomic factors, but exposed to differing average pollution levels, with a control group in an air pollution-free area. A presurvey evaluation of health status, clinically if possibly, or a health questionnaire are useful comparison devices. Significant data for acute episodes can be more easily gotten, whereas the chronic effects of normal pollution will require years of study for valid assessment.

343. Kingsley, I.: How to control dust and vapors. Modern Sanitation 6, No.9:23-6, 1954.

This is a useful review of the various methods of dust and fume collection by filtration, dynamic precipitation, wet collection, electrostatic precipitation and sonic devices, and of gas and vapor collection by absorption, adsorption, combustion and condensation. The equipment used, the advantages and disadvantages of each type and the % efficiency and the size particles collected in each case are described. Proper stack height and curtailed production during unfavorable meteorological conditions also provide effective control of pollutants.

344. Kotin, P.: Medical investigation of air pollution. Laboratory methods. Arch. Ind. Hyg. and Occupational Med. 10:288-94, 1954.

The theoretical chemical and biological considerations involved

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Kotin, P. (continued)
in planning and carrying out a medical investigation of air pollution and how these can best be translated into laboratory methods are discussed. Chemically, the problem involves qualitative and quantitative reproduction of air pollutants in the laboratory. This requires knowledge not only of pollutant sources, but also of the photochemical activity on the emitted pollutants. Since the chief characteristic of Los Angeles smog is its marked oxidizing capacity, the oxidant effect on certain animals was selected as the initial test material in the preliminary investigation and a concentration of 4 ppm total oxidant (10 X that present in heavy smog) was chosen. Biologically, the study was carried out both in vitro and in vivo. In vitro studies were made on amino acids, vitamins, nonprotein hormones, purines and pyrimidine compounds, porphyrin group compounds, blood and blood pigment substances, serum proteins and enzyme systems. In vivo studies included studies on proteins and enzymes, respiratory physiology, amino acids, hemoglobin, pathology and electrolytes. Extrapolation of these findings to human circumstances is the most difficult part, for host response is another variable. Comparison of animal reactions to experimental conditions simulating abnormal air pollution concentrations with human reactions might be tried. In chronic studies, experiments on cancer of the lung induced in animals might be oriented toward duplicating human experience.

345. Laidlaw, S.I.A.: The effects of smoke pollution on health. J. Inst. Fuel 27:96-9, 1954.
The effect of diminution of sunlight (formerly giving rise to rickets from the consequent lack of Vit. D) by air pollution, the noxious effects of the main impurities of pollution (e.g., dust, soot, fog, SO_2, CO, Be compounds and tobacco smoke) and air pollution as one of the possible causes of bronchial or lung carcinomas are discussed. Statistics are mentioned in support of the discussion, but not shown.

✓346. Largent, E.J.: Metabolism of inorganic fluorides. In: Shaw, J.H., ed.: Fluoridation as a Public Health Measure. Washington, D.C., American Association for the Advancement of Science, 1954, pp. 48-78.
The metabolism of inorganic F compounds is discussed on the basis of experimental work, of the urinary F excretion in certain cities providing drinking waters with various concentrations of F, and of the distribution in tissues of laboratory animals, and of cattle that had grazed near a rock phosphate factory. A number of observations of fluorosis among cattle or sheep near factories, as reported in the literature to 1950, are tabulated as to type of factories and location.

347. Los Angeles County Air Pollution Control District: Smog. What has been done; what must be done. Los Angeles, 1954, 11 pp.
The Los Angeles County Air Pollution Control District reviews for the general public why Los Angeles County has smog, what are the makings of smog, what smog does, what has been done about control and what is yet to be done.

348. McCabe, L.C.: Air pollution review 1949-1954. Ind. Eng. Chem. 46:1646-50, 1954.
This is a review of the work done in basic research, analysis and prevention of air pollution by various laboratories and organizations throughout the country, of environmental pollution surveys of various cities and of the acute air pollution episodes in Poza Rica, 1950 and London, 1952. (47 references.)

349. Mallette, F.S.: A new frontier: air-pollution control. Proc. Inst. Mech. Engrs. 168:595-628, 1954.
A historical review, particularly of Great Britain and U.S., is presented. The legislation and accomplishments in air pollution control in St. Louis, Alleghany County and Pittsburgh, New York City, California, Los Angeles County and Canada are rather extensively reviewed. Meteorological concepts and factors are discussed. A statistical analysis of concentrations of SO_2 and total particulate matter in relation to meteorological conditions at Donora indicated the shortcomings in the data collected, showed that wind direction and speed, vertical temperature lapse rate and wind shear were the influencing factors on pollution at Donora, and that only about 1/2 of the variability of the SO_2 contamination could be accounted for by an objective statistical prediction model. A brief account of the Donora smog episode is given and the agents possibly responsible for the deaths are discussed. The development of sampling and measuring instruments for dust, smoke, SO_2 and of meteorological instruments is reviewed. The air pollution problems of the iron and steel industry with respect to each operation are also discussed extensively. Examples of control problems in the steel, power, chemical and rubber industries are given. Finally socioeconomic considerations are discussed rather briefly. There follow discussions of the paper, mainly along engineering lines, by various members of the Institution of Mechanical Engineers from London, Manchester and Glasgow and communications from various other interested persons. The reply by the author is included.

350. Mesler, R.B. and Widdoes, L.C.: Evaluating reactor hazards from airborne fission products. Nucleonics 12, No.9:39-41, 1954.
Maximum possible hazard from a nuclear incident in which all of a reactor's radioactive contaminants are dispersed into the air can be evaluated by the methods presented in this article. This includes the evaluation of contaminant concentration downwind from the source, external doses, inhalation doses and doses from fallout. The steps that can be taken to reduce these hazards are briefly discussed.

351. Mills, C.A.: Air Pollution and Community Health. Boston, Christopher Publishing House, 1954, 180 pp.
This is a discussion of the problem from a personal viewpoint with special reference to the Donora incident and to the author's interpretation of the investigations carried out there by the U.S. Public Health Service and the Kettering Laboratory.

352. Parker, A.: Atmospheric pollution: causes, effects, and prevention. J. Inst. Civil Engrs. 3:99-124, 1954.
This general discussion of air pollution reviews the nature and amount of pollution from the use of fuels, the distribution of pollution and its measurement, detrimental effects of pollution and abatement of pollution. Tables (sources not quoted) giving the

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Parker, A. (continued)
quantities of the various fuels, viz., coal, coke, gas, electricity and petroleum products, that were consumed domestically and industrially in 1951 and the quantities of pollutants given off from combustion processes are included. The contribution of motor vehicles to air pollution is also discussed. The incidence of pollution varies greatly from one locality to another and with the time of the year and changes in meteorological conditions. Systematic measurements by cooperating organizations, some on a daily basis and others monthly, are made with deposit gauges, SO_2 instruments and smoke filters; the total number of instruments in use is ca. 1,350. The results of the measurements are very generally discussed. In addition, special investigations concerning factors affecting the dispersal of pollutants in the atmosphere are undertaken by the Fuel Research Station. The various detrimental effects on property, agriculture and health are briefly listed. All economical steps to abate pollution should be taken, e.g., coal-cleaning and more efficient utilization of fuel, especially domestic fuel. Changeover to smokeless fuels and central heating systems would curtail the emission of smoke. Most grit can be easily removed from flue gases. Various processes have been used to remove SO_2 from flue gases, especially at power stations. Perhaps the most promising is the ammonia gas liquor process. CO is not considered as too serious a pollutant, except perhaps in dense traffic.

353. Princi, F.: Public health aspects of atmospheric pollution. Am. J. Public Health 44:206-10, 1954.
This is a discussion of what kind of work is, and can be, done in the study of air pollution. A review of the acute episodes of air pollution shows that no clear-cut cause and effect relationship was demonstrable, except in the Poza Rica incident. More adequate studies can be carried out in the next acute episode. Studies of long-continued exposures have been made by various means, e.g., air sampling, animal experimentation and to a very limited extent, human experimentation and epidemiological studies. An established clinical syndrome is lacking; this might be obtained through properly conducted medical investigations of industrial exposures. It must be realized that air pollution cannot be entirely eliminated, but that a rational balance between industry's right to a reasonable operation and the public's right to a decent environment can be obtained.

354. Scorer, R.S.: Smog. Science Prog. 42, No.167:396-405, 1954.
Air pollution causes greatest damage during acute episodes when meteorological conditions concentrate the pollutants and intensify their action. Therefore, averaged measurements collected over a period of time mean very little. The effect and behavior of solid particles, SO_2, CO and CO_2 under various meteorological conditions are discussed. The characteristics of smoke plumes from industrial and domestic fires were also discussed under the same aspect. The author suggests elimination, as far as possible, of the efflux of tiny solid particles into the atmosphere, higher power station chimneys and emission of as hot effluent gases as possible for better dispersion.

355. Teleky, L.: Nebel und Nebelkatastrophen. (Fog and catastrophes caused by fog.) Arch. Gewerbepathol. Gewerbehyg. 13:6-28, 1954.

The effects of natural fog, of smoke and of the combination of the two are discussed in an interesting historical review, substantiated by dates and other data. The complaints against "smog" are traced back to the more dense population within certain areas and particularly to the beginning of the use of bituminous coal for domestic and industrial purposes. The earliest date recorded is 1257 when smoke in Nottingham became so noxious that Queen Eleanor was forced to leave the city. The growth of the production and consumption of coal and the volume and composition of the effluents caused by its use are illustrated with figures. Values are cited for SO_2 concentrations in Pittsburgh for 1932; of N oxides, NH_3, Cl and H_2SO_4 for Chicago (1912-13); Cl, NH_3, H_2SO_4, N oxides and SO_2 in Salt Lake City (1919-20) and SO_2 in Washington (1926-28). The fog episodes in London County from 1873 to 1952 are listed, together with duration and resultant morbidity and mortality, and the conditions of the episodes are analyzed. The emission of contaminants other than those produced by the burning of coal and their effects on vegetation and animals are discussed, as are regulatory orders adopted in 1869 in Germany and in 1863 in Great Britain. The Meuse Valley and Donora fog disasters and the Poza Rica accident are interpreted in fairly great detail. Although Batta, Firket and Leclerc of the Meuse investigating board concluded from their survey that SO_2 and H_2SO_4 were the chief cause of the illnesses, but that in the direct vicinity of their factories the effects of HF could not be excluded, Flury, Roholm and others, including Teleky, believed that F was the principal cause. The causes for the catastrophic episodes of the combination of fog and atmospheric pollution, and what can be done about them, are discussed.

356. Turk, A.: Odorous atmospheric gases and vapors: properties, collection, and analysis. Ann. N.Y. Acad. Sci. 58:193-214, 1954.

The properties of molecular weight, boiling point, freezing point, ordinary state and vapor pressure (mm.) for the lightest odorant of several homologous series of gases and vapors and of other atmospheric odorants are tabulated. The properties upon which the odorous characteristics depend are discussed. Methods of collection, i.e., by adsorption, absorption and condensation; quantitative analysis by oxidimetry and quantitative measure of C adsorption and qualitative analysis by mass and infrared spectral analyses of odorants, including mathematical relationships, are also discussed.

357. Andrews, H.L.: Radioactive fallout from bomb clouds. Science 122:453-6, 1955.

The problem of radioactive fallout from bomb clouds and what dangers are involved are discussed. Each detonation made in peacetime testing is carefully considered several times before the firing by a panel of specialists in the fields of atomic medicine, radiation health protection, blast and meteorology. The nature and mechanism of formation of the fallout particles are described. If the bomb is exploded high in the air, much of the radioactivity is dispersed at the high altitude and radioactive fallout, or the return of the radioactive materials to the earth's surface, will be greatly delayed or may not take place at all. If detonation occurs at a low altitude, dirt and dust will be drawn up into the cloud and many fission fragments will condense onto the particles during mixing

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Andrews, H.L. (continued)
and cooling. The fallout of this material is much more serious. The presently accepted standards for whole-body radiation exposure by the National Committee on Radiation is 0.3 roentgens/week for personnel planning to work with radiation for long periods of time; by the AEC it is an annual dose of no more than 3.9 roentgens that may be received at any rate or over any period of time. The possibilities of β-particle burns and injury from inhalation, of β-particles entering the body from the use of exposed food and H_2O and of a genetic effect on future generations are also discussed. β-Particles do not produce the generalized injury associated with γ-radiation, but their action will be more intense in one spot. A limit of 1.5 roentgen equivalent physical/week of β-particle radiation to limited areas, e.g., the hands, is recommended by the National Committee on Radiation Protection. Active fallout can usually be predicted and warned against and people who have received it directly on their skin can remove practically all the particles by washing or vigorously dry-brushing. Though it is inevitable that some slowly falling particles will enter the respiratory system during active fallout, very few respirable particles are likely to be radioactive, since a 5µ particle requires 70 days to fall 40,000 ft. Examples are given to show the tremendous amount of contaminated food and H_2O that would have to be ingested in an area where fallout is serious to reach permissible limits. Little is really known about the genetic effect as yet.

358. Andrews, J.M.: An epidemiologic approach to the problems of community air pollution. Proc. 3rd Natl. Air Pollution Symposium, Pasadena, Calif., April 18, 19, 20, 1955:136-40, 1955.

In this discussion of the epidemiology of air pollution, it is noted that there is a growing interest in the need for air pollution control, especially in government circles. The progress in this direction is about 100 years behind that of H_2O pollution. It is the field of the epidemiologist to obtain the necessary knowledge for effectively combatting air pollution for he is concerned with the diagnosis, control and prevention of disease and he deals on a mass basis with the health of total communities or groups of people. In the past epidemiology has been most effective in discovering the cause and thus overcoming communicable diseases, nutritional diseases and certain environmental hazards. However, in air pollution it is not possible to group individuals into those with and without health defects which may be due to air pollutants because no constant pattern of bodily changes characteristically and exclusively associated with air pollution is apparent. One method of attack has been to assemble groups according to amount of air pollution exposure and seek to determine the significant differences between those living in high and low pollution areas. An example of this is the Detroit-Windsor investigation. Another approach is to determine and carry out mass physiologic tests for detecting abnormalities in the cardiac or respiratory systems of exposed people. Dr. Phair of the University of Cincinnati has been conducting such an investigation. Another method is to make laboratory tests on the detoxifying and excretory organs, viz., liver, kidneys, intestines, blood and skin of the masses to determine metabolic changes before they appear clinically. The rest of the paper presents a brief résumé

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Andrews, J.M. (continued)
of plans for enlarging the program of the U.S. Public Health Service that is related to community air pollution. These plans are based on the belief that its role in this field should be (1) to support and conduct health-related research not likely to be undertaken by states, communities or private organizations, (2) to collect and disseminate knowledge, (3) to demonstrate new principles and practices and (4) to provide consultative and other technical assistance.

359. Anonymous: Catalyst for pollution studies. Chem. Eng. News 33:2084, 1955.
This is an interview of Louis C. McCabe and of his views on government and air pollution. He states that air pollution should be controlled on the local level. The role of the U.S. Public Health Service in air pollution studies is also reviewed.

360. Anonymous: 8 at city hall treated in worst smog attack. Los Angeles, Cal., Examiner 7/20/55. Smog News No.47:11, 1955.
News item on complaints of eye irritation, headache and difficulty in breathing during a severe smog is reported.

361. Anonymous: Public health and air pollution. Federal funds now on tap let U.S. Public Health Service study how air pollutants affect human health. Chem. Eng. News 33:2496, 2499, 1955.
For the first time, the U.S. Public Health Service has been granted federal funds to perform studies on the effects of contaminants on human health. An outline of Public Health services is given. Organic pollutants, damage to vegetation, the disposal of radiological wastes and odor control are generally discussed.

362. Anonymous: Sulphur dioxide in air adds to discomfort here. The New York Times 7/23/55. Smog News No.46:12, 1955.
"A large mass of warm air about 280 ft. above ground was blamed by experts at the Department of Air Pollution Control for a heavier-than-usual concentration of SO_2 around town. Many complaints of reddened, moist eyes were received during the morning. The department's instruments showed ca. .02 - .025 ppm SO_2. Ordinarily at this time of the year the ratio would be ca. .01 ppm. Air pollution spokesmen emphasized that SO_2 is a normal product of industrial combustion and that, during the winter, a considerably higher concentration is comfortably tolerated by metropolitan breathers. What caused the trouble yesterday, they explained, was an unfortunate combination of heat, humidity, fumes and air arrangement. Three Western Union messengers in Brooklyn were among the first to report back to their office that their eyes were affected seriously enough to interrupt their bicycle rounds."

363. Bergsma, D.: Public health responsibilities in air pollution. Public Health News (New Jersey State Department of Health) 36:276-80, 1955.
This is a discussion of what constitutes and what influences health and what kind of legislation has been taken to control air pollution so that it will not injure health and yet not overburden industry. It further reports on the personnel and powers of the Air Pollution Control Commission in the New Jersey State Department of Health.

364. Breslow, L.: The epidemiologist looks at smog. Public Health Repts. (U.S.) 70:1140-3, 1955.

This is a discussion of smog, its variability and its immediate and long-term effects on health. The mortality and morbidity studies done on the elderly and infants in Los Angeles in the fall of 1954 failed to show any significant effects of smog on health. (For a more detailed report of this study, see abstract: California State Dept. Health: Clean Air for California. San Francisco, Calif. Dept. of Public Health, 1955, 60 pp.) However, the studies did not continue for a long enough period for very conclusive results. Further, opinions of Los Angeles physicians and results of a telephone survey of Los Angeles school administrators and teachers indicated a definite adverse effect of smog on the health of people and pupils, respectively. Studies of long-term effects on people in England have been reported by Stocks, P. (Regional and Local Differences in Cancer Death Rates. General Register Office Studies on Medical and Population Subjects, No.1. London, H.M. Stationery Office, 1947) and such investigations on residents of Los Angeles are being planned. Smog is considered a health hazard "because of its obvious, immediate interference with the physical, mental and social well-being of the people; its possible, but as yet undetermined, cumulative adverse effects upon health; and its disaster-making potential, should pollution concentration build up in any area."

365. Burns, J.E.: Asthma, chronic bronchitis, and emphysema. Letters to the Editors. Lancet II:821, 1955.

The asthmatic and chronic bronchitic suffer greatly in winter in the industrial towns of England which have persistent smoky haze and occasional smog. It is suggested that a simple type of accommodation, linked to the hospital service and fitted with air conditioning, might be provided for these people where they could spend part of the winter. A prompt and noticeable improvement has been noted when these patients breathe clean air. Alternatively, it is suggested that Remploy workrooms with air conditioning be extended in large centers of population where these patients could attend and have interesting and useful work instead of enforced idleness. The greatest amount of air pollution occurs in the "black areas" where asthma and chronic bronchitis is not only a severe but a frequent condition. Reduction of air pollution must be an important part of a preventive program against chronic chest disease. This letter was written in reference to Dr. Lister's article: Asthma, chronic bronchitis, and emphysema. (Lancet II:733-7, 1955.)

366. Editorial: The battle against smog. J. Am. Med. Assoc. 158:403, 1955.

This discussion on the smog and air pollution problem in Los Angeles also briefly reviews the functions of the Air Pollution Foundation in Los Angeles. It is suggested that laws be enacted and enforced in accord with the best current knowledge on air pollution, that all open fires for burning rubbish be prohibited and that motor vehicle fumes be reduced by a cooperative public while the results of research projects on air pollution control are being awaited.

367. Editorial (Stead, F.M.): Health effects of air pollution. Arch. Ind. Health 12:583, 1955.

Five separate and distinct levels of health impairment which may

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Editorial (Stead, F.M.). (continued)
result from air pollution are defined. They are (1) destruction of the stimulating effect of clean, clear air; (2) interference with comfort; (3) interference with normal performance; (4) occurrence of demonstrable illness and (5) death. This distinction of levels should stimulate accurate and precise observations on animal physiology as related to air pollution and the development of objective standards of air pollution as related to effects on animals.

368. Gafafer, W.M.: Air pollution--some epidemiologic aspects. Am. Ind. Hyg. Assoc. Quart. 16:196-200, 1955.

Epidemiology is defined as a discipline dealing with the study and analysis of the various elements that determine the frequency and distribution of a disease or condition, the findings eventually becoming useful in the formulation of recommendations for prevention and control. The various elements determining the frequency and distribution are designated as the relevant factors. Some of the major ones of these, in the study of the health effects of air pollution, appear to be age, health status, race, sex, psychologic characteristics and inherent traits and factors arising from the social, economic and physical conditions. Though the definition refers to the frequency and distribution of a disease or condition, in the case of air pollution the disease entity or specific condition is not known. The study of the health effects must then begin on a broad enough basis to cover the specific entity, or the investigator may search along the lines of certain diseases or syndromes suspected to be associated with air pollution. The results of studies made on the London fog of 1952 and the current Detroit-Windsor and California studies are reviewed. The results are more fully covered in the abstracts for the following:

The Detroit-Windsor International Program--A scientific approach to the study of the influence of air pollutants on community health. Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952:94-116, 1952.

California, State of, Department of Public Health: Clean Air for California. Initial report of the Air Pollution Study Project. California, Dept. of Public Health, 1955, 60 pp.

The study of the London fog revealed no 1 pollutant as the cause of death, and the preliminary review of health data in the Calif. study and an initial inspection of some of the health data collected in the Detroit-Windsor study suggested that there are, generally, no health effects from air pollution on the population. Such negative preliminary results indicate that greater efforts should be made in the use of the sickness survey and in determining the true relevant factors.

369. Great Britain, House of Commons: Clean air. A bill to make provision for abating the pollution of the air. Bill 40, July 26, 1955,

The four main purposes of the Bill are: prohibition of the emission of dark smoke from chimneys, prohibition in industry of new furnaces other than smokeless ones, limitation of the emission of grit and dust from existing furnaces and the installation of grit-arresting equipment in new ones, and empowerment of local authorities to declare "smoke-control areas."

The Bill also provides for payment by the Exchequer and by Local Authorities toward the cost of conversion of appliances in private

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Great Britain, House of Commons. (continued)
homes in smoke-control areas. It amends and extends the operation of the Alkali, etc., Works Regulation Act of 1906 and provides for penalties for offences under the Bill. (Abst. Bull. Hyg. 31:550, 1956.)

370. Hitchcock, L.B. and Marcus, H.G.: Some scientific aspects of the urban air pollution problem. Sci. Monthly 81:10-21, 1955.
The problem in Los Angeles is particularly treated in this discussion of urban air pollution. The analysis and instrumentation for each constituent in smog are reviewed. Control by means of reduction at the source with collection equipment, dilution of the source, as with tall stacks, and by planned allocation of land is discussed. The amounts of pollutants/100,000 registered automobiles in Los Angeles are estimated as CO, 280 tons/day; N oxides (as NO_2), 7.7; hydrocarbons, 44; SO_2, 1.8; aldehydes, 1.8; Pb, 0.05; oil droplets (aerosols), 1.3. Reduction of these combustion pollutants is discussed. The physiological effects of air pollution are not fully known but are thought to include cancer, irritation of the eyes and respiratory tract, noxious odors and tastes and reduced visibility. Data from industrial toxicology, studies of catastrophes and analyses of routine morbidity and mortality records have their limitations. The methods of the study recently begun by the University of Cincinnati College of Medicine are described. Economic loss in material goods, crop damage and poor combustion are discussed. The damage to plants from smog is described.

✓ 371. Hueper, W. C.: Medicolegal aspects of cancer. Am. J. Clin. Pathol. 25:116-25, 1955.
There is a marked discrepancy between the number of cancers forming the basis of compensation claims and that being of recognized occupational origin. Numerous different types of cancer and their alleged causes are discussed. As to primary acute traumatic cancer, it is stated that there is neither experimental nor clinical evidence of a primary causation of cancer by a nonspecific, acute, physical or chemical injury of the normal tissue. Also in secondary traumatic cancer, the direct carcinogenic effect is not exerted by the trauma. Rather, it produces environmental or metabolic changes contributing to the development of cancer, or it introduces specific exogenous carcinogens into the tissue. The problem of a possible relationship between environmental pollutants and the occurrence of cancer in exposed persons is examined in detail, and its medicolegal aspects are outlined. Numerous environmental agents are mentioned with reference to their reported cancerogenic properties. In addition to the experimental and clinical evidence of their action on the skin, and, subsequent to ingestion, on other organs, the significance of the following air pollutants with respect to the incidence of lung cancer or other respiratory diseases is reviewed: air contaminants in city air, soot, polycyclic hydrocarbons in the exhaust gases from gasoline and diesel engines, aromatic amines, Be and, according to most recent information, atomic radiation. It is stressed, however, that the mere demonstration of carcinogens in the environment does not establish a causal relationship to cancer occurring in exposed persons. The intensity, duration and route of exposure, the length of the latent period, the site of the cancer and the agent incriminated are of essential significance. The demonstration of the causal agent in the body, or of carcinogenic metabolites in the blood and

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Hueper, W. C. (continued)
urine, or the presence of precancerous symptoms characteristic of exposure to a specific carcinogen would be conclusive. There can be no doubt that the nature of the exogenous agents causing cancer of the skin and that of the lungs is identical. The author recommends discontinuing the use of the term "traumatic cancer" and replacing it by the less ambiguous term "environmental cancer." The medicolegal aspects of the problems under discussion are described in detail, particularly with regard to compensation claims.

372. Hueper, W. C.: Environmental causes of cancer of the lung. Public Health Monograph No. 36. (Public Health Service Publication No. 452.), 1955, 54 pp.

This is a comprehensive review of general epidemiological considerations and occupational evidence and respiratory carcinogens. Numerous epidemiological lung cancer references dating back to before 1900 are considered. "It is apparent from this discussion on the observation and facts of general environmental nature cited that there exists an impressive amount of circumstantial evidence of different character and from various sources which strongly suggests that several, if not many, environmental factors acting in varying degrees and combinations cause or contribute to the development of pulmonary cancers and are involved in their recent rise in frequency. Much of the evidence on hand, particularly the irregular epidemiological pattern of lung cancer, points to an important role which industry-related factors and the growth of modern industry may have assumed in these respects." Though the epidemiological data on large industrial groups are not complete, the data show that a large number of workers employed in basic and processing industries, construction, transportation, services, trades, laboratories and professions are exposed to various occupational carcinogens of known or still unknown nature. A general view of the occupational respiratory cancer panorama, including causal agents and organs affected, is presented in table form. The distribution of cancer in the respiratory tract is affected by a) the "traffic pattern" of the air pollution, i.e., the air flow at the narrowing of the larynx, at the bronchial bifurcations and at dead end sacculations and b) by the physicochemical state of the atmospheric carcinogens which influences the site of deposition or contact. The following specific carcinogens are reviewed in detail as to use, type of exposure and incidence and site of cancer caused by carcinogen: Ni, Cr, As, Fe, Be, combustion and distillation products of coal, petroleum, shale oil and natural gas, asbestos, isopropyl oil, mustard gas and radioactive chemicals. It is concluded that "the data on hand make it unlikely that cigarette smoking represents a major factor in the production of lung cancer and its recent phenomenal rise in frequency." An extensive bibliography of ca. 360 references is included.

373. Katz, M.: Atmospheric pollution studies with particular reference to the Detroit-Windsor area. Air Repair 4:176-83, 1955.

Atmospheric pollution in general and the nature of atmospheric contaminants are discussed. Some of the recent developments in environmental studies are reviewed by summarizing the air pollution concentration data for Baltimore, Cincinnati, Donora, Los Angeles and Windsor. The data are taken from Cholak, J., et al.: Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., 1952:6-15, 1952, Katz, M.: Ibid. 1952:95-105, 1952 and Los Angeles County

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Katz, M. (continued)
Air Pollution Control District, Los Angeles, Calif., Ann. Repts., 1948-51. The International Windsor-Detroit problem and the work being done on it are also briefly reviewed. A summary of analytical methods and equipment used for determining common air pollutants, taken from Clayton, G.D.: American Gas Association, PC-52-12, May, 1953, is included.

374. Katz, M., Nelson, N., Gex, V.E. and Chambers, L., MacKenzie, V.G. and Fotor, M.J.: Control of air contaminants. Public Health Repts. (U.S.) 70:194-7, 1955.

Four papers dealing with air pollution were given at the 82nd Am. Public Health Assoc. Conf., Oct. 11-15, 1954. M. Katz urged the study of prolonged exposure to air contaminants by correlating fundamental environmental and meteorological observations with measurements of ill health as illustrated in the Detroit-Windsor study. He proposed that in acute episodes, possibly the organic constituents are more important than the inorganic. V.E. Gex reported the work done at Procter and Gamble Co. on odor measurement and odor control by stack disposal, operating techniques, process change and control equipment. N. Nelson advocated further study on the possibility of enhanced susceptibility of persons already under stress, i.e., the very young and the very old, on the effect of the physical state of pollutants, and on the possibility of unsuspected irritants. He also advocated a search for functional changes in relation to air pollutants and briefly discussed lung cancer and air pollution. L.A. Chambers, V.G. MacKenzie and M.J. Fotor reviewed the work of the Sanitary Engineering Center in Cincinnati, O. prior to 1954 and also the activities now being started there, viz., expansion of the exploratory sampling network, evaluation and development of sampling equipment and analytical procedures for gases and volatile substances, study of physiological effects to establish control standards, extension or correlation of pollutant loadings and mortality data to more cities and a technical study of community control patterns.

375. Kotin, P. and Hueper, W.C.: Relationship of industrial carcinogens to cancer in the general population. Public Health Repts. (U.S.) 70: 331-3, 1955.

This is a general discussion of the potential hazard of industry-related carcinogens, the methods of study, routes of entering the environment, sites of attack and known or suspected carcinogens, and of air pollution and lung cancer.

✓ 376. Lister, W.A.: Asthma, chronic bronchitis, and emphysema. Lancet II:733-7, 1955.

The author discusses the physiological aspects, diagnosis and treatment of asthma, chronic bronchitis and emphysema, and he gives evidence in support of his opinion that the 3 should be looked on not as separate entities but as an integrated sequence of pathological change. Cold, damp, foggy weather, atmospheric smoke and the use of tobacco are taken for granted as etiological factors in these diseases.

377. Ludwig, J.L.: Statement of Dr. J. Lafe Ludwig on S. 928 before Senate Subcommittee J. Am. Med. Assoc. 158:192-3, 1955.

This is a general discussion of air pollution in its relation

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Ludwig, J.L. (continued)
to health and of the need for further research in this field. The author concludes that S. 928 represents a proper approach to the problem, but that provision should be made in the bill for medical representation on the Air Pollution Control Advisory Board which would be established by the bill.

378. Mallette, F.S.: Problems and Control of Air Pollution. Proceedings of the First International Congress on Air Pollution held in New York City, March 1-2, 1955 under the sponsorship of the Committee on Air-Pollution Controls of The American Society of Mechanical Engineers. N.Y. Reinhold Publishing Corp., 1955, 272 pp.

The general topics covered in this book on air pollution are: gaps in the available knowledge on air pollution; current developments in air pollution; sulfur dioxide--treatment and recovery and experience in air pollution abroad. These are discussed in the following chapters:

1. Beaver, Sir H.E.C.: The growth of public opinion, pp. 1-11.
2. Pendray, G.E.: Management aspects of air pollution, pp. 12-22.
3. Nelson, N.: Biological aspects of air pollution, pp. 23-31.
4. Stern, A.C.: Administrative needs and patterns of air pollution control, pp. 32-41.
5. Silverman, L.: Engineering research and development in air-pollution control, pp. 42-9.
6. Hewson, E.W.: Meteorological problems in air-pollution control, pp. 50-63.
7. Middleton, J.T.: Biological systems for the identification and distribution of air pollutants, pp. 64-8.
8. Watkinson, E.A.: Associated health implications in air-pollution control, pp. 69-73.
9. Davis, R.F. and Holtz, J.C.: Exhaust gases from diesel engines, pp. 74-94.
10. Rose, A.H., Jr. and Crabaugh, H.R.: Research findings in standards of incinerator design, pp. 95-106.
11. Sinclair, D.: Measurement of average particle size in aerosols by light scattering, pp. 107-20.
12. Newbury, B.C.: The Sarnia survey: action without compulsion, pp. 121-31.
13. Carrington, J.C.: The world supply of sulfur, pp. 133-42.
14. Rees, R.L.: Removal of sulfur dioxide from power-plant stack gases, pp. 143-54.
15. Hein, L.B., Phillips, A.B. and Young, R.D.: Recovery of sulfur dioxide from coal combustion stack gases, pp. 155-69.
16. Newall, H.E.: Ammonia process for removal of sulfur dioxide from flue gas, pp. 170-90.
17. Smalley, G.E. and Klohr, J.W.: Recovery of refinery sulfur in air-pollution control, pp. 191-201.
18. Colclough, T.P.: Sulfur in iron- and steelmaking, pp. 202-14.
19. Kurtz, J.K.: Recovery and utilization of sulfur from coke oven gas, pp. 214-21.
20. Lawler, W.C.: Use of a sulfur dioxide scrubbing system in air-pollution control, pp. 222-4.
21. van Ebbenhorst Tengbergen, H.J.: Influence of the size of the dust outlet on the efficiency of cyclones, pp. 225-35.
22. ter Linden, A.J.: Air pollution in Holland, pp. 236-44.
23. de Azevedo, N.F.dos S.: A biotic disease in forest species, pp. 245-51.

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Mallette, F.S. (continued)
24. Pancheri, G.: Industrial atmospheric pollution in Italy, pp. 252-63.
25. Avy, A.P.: Air pollution by dust fume, and smoke, pp. 264-72.

379. Manufacturing Chemists' Association, Inc.: Air Pollution Abatement Manual. Washington, D.C., 1951-5, 12 chap.

The individual chapters in this manual are abstracted under their respective authors, which see:
Gosline, C.A.: Preface and outline
Gillet, J.M.: Introduction to a manual of air pollution abatement
Hodge, W.W.: Terminology and selected data
Bulkley, R.J.: Community relations
Seamans, F.L.: Legislative requirements
Adams, E.M.: Physiological effects
Magill, P.L.: Sampling procedures and measuring equipment
Cralley, L.V.: Analytical methods
Helmers, E.N.: The meteorology of air pollution
Lapple, C.A.: Dust and mist collection
Jenny, R.J.: Gas and vapor abatement
Falk, L.L.: Evaluation of data
Jenkins, G.F.: Bibliography

380. Murk, J.B.: Sources of air pollution literature. Ind. Eng. Chem. 47:976-81, 1955.

This is a bibliography of bibliographies on air pollution in which legislation, institutional work and symposia are cited. Comprehensive bibliographies have been prepared by the Stanford Research Institute, the Manufacturing Chemists' Association, the Mellon Institute, the Office of Technical Services, the U.S. Dept. of Commerce, the Atomic Energy Commission, the Bureau of Mines and the Federal Security Agency. Other collections of air pollution papers and literature have been prepared by the McGraw-Hill Book Co., the University of Mich. and Ind. Eng. Chem. Suggested subject headings for further search, publications abstracting air pollution literature, periodicals devoting considerable space to air pollution and associations and institutes interested in air pollution are listed.

381. National Research Council: Abatement of Highway Noise and Fumes. Highway Research Board, Bull. 110, Washington, D.C., 1955, 47 pp.

This manual is mainly concerned with the abatement of noise on the highway. A small section gives a preliminary report on reduction of fumes. The toxic substances from exhaust gases discussed are CO (in some detail), acrylic aldehydes, Pb and benzol. Conditions under which traffic fumes may enter motor vehicles are considered. These traffic fumes may impair judgment, slow reflexes and even overcome the driver sufficiently to cause him to lose control of his car. Suggestions in car operation and roadside design to lessen the dangers of traffic fumes are made.

382. Nelson, N.: Some toxicologic aspects of atmospheric pollution. Am. J. Public Health 45:1289-1301, 1955.

This is a critical discussion of the health aspects of air pollution restricted to the 2 facets of respiratory irritants and lung

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Nelson, N. (continued)

cancer. The findings of the Donora and London fog episodes and of the researches of Amdur, et al. on SO_2 and H_2SO_4 mist and of Haagen-Smit, et al. on the Los Angeles problem are considered. It is thought that the effects of the low concentrations of SO_2 and H_2SO_4, as used by Amdur in her experiments, would be enhanced and would be significant in individuals with impaired respiratory or cardiac function. That the low concentrations of 0.34-0.5 mg./l. H_2SO_4 mists showed changes in pulse rate, tidal volume and respiratory rate without the detection of the toxin by the healthy individual should be considered in pollution investigations, for such functional changes are not observable after exposure. Therefore post-investigations of pollution episodes, e.g., at Donora, do not reveal these effects which might have occurred in healthy individuals, whereas in individuals already under stress, these irritants might have had more drastic effect that led to quite definite organic changes. This should be considered with other irritants also. Physical state of pollutants, e.g., particulate vs. gas, is another important factor of the problem that should be given close scrutiny, and the possibility that pulmonary irritants, other than those conventionally accepted as important in the past, may be making a significant contribution requires more study. It would seem that nonspecific irritants acting separately or additively may be one of the most important toxic effects of air pollutants for the respiratory system. Briefly reviewing the studies of the incidence of lung cancer with smoking habits and air pollution, it is concluded that (1) there is probably a higher incidence of lung cancer in urban than in rural groups, (2) urban and industrial centers have higher concentrations of known carcinogens than areas with less pollution and (3) no definite conclusion can be based on these possibly related factors at this time. Considering the sex differences in lung cancer, if one assumes that the sexes are equally susceptible, then smoking perhaps more readily fits the available data than does air pollution, since the frequency of smoking among women has only in recent years approached that among men, but both sexes have been presumably equally exposed to air pollution. If this is true, the present disparity should disappear in the future. However, if the assumption of equal susceptibility of the sexes is wrong, the present disparity would be expected to persist.

383. Pancheri, G.: Industrial atmospheric pollution in Italy. In: Mallette, F.S.: Problems and Control of Air Pollution. Proceedings of the First International Congress on Air Pollution held in New York City, March 1-2, 1955 under the sponsorship of the Committee on Air Pollution Controls of The American Society of Mechanical Engineers. N.Y., Reinhold Publishing Corp., 1955, Chap. 24, pp. 252-63.

Industry has been steadily developing in Italy with resultant air pollution. Some anti-pollution legislation has been enacted but it is now out-of-date. It is the author's opinion that many cases of collective toxicity from industrial atmospheric pollution have gone unreported. As an example of sensitivity in certain individuals to some substances, the case of a worker who had given up his job in a factory producing metal fixtures because of an eczema which he

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Pancheri, G. (continued)
had developed from vapors of H_2SO_4 and HNO_3 is cited. Many years later he suffered a recurrence of his ailments because acid fumes from a workshop below his apartment reactivated the latter. In another case, a number of persons residing in sanitoria in Merano, who suffered from respiratory diseases, showed an increase of subjective symptoms of their diseases, because of effluents from a factory manufacturing synthetic NH_3 and artificial fertilizers. The psychologic aspects of air pollution are acknowledged. Illness in residents, domestic animals and destruction of silkworms around an Al factory in the Province of Trento are also reported. According to the report of the Institute of Public Health of Italy, the atmospheric concentrations of F and As in the vicinity of the factory were low, maxima of 0.02 and 0.002 mg./m^3, respectively; traces of F and As were also found in places removed from the factory. CS_2 and H_2S from a viscose-rayon factory in the Piedmont around 1935 caused ailments for several years in the people living in approximately a 10 km. radius. The complaints were nausea, irritation of the eyes, lack of appetite, general irritability, headache, insomnia, dyspepsia and others. Analysis of the air showed concentrations of 0.03-0.15 mg. H_2S /m.^{3}, 0.02-0.09 mg. CS_2/m.^{3} 0.03-0.05 mg. mercaptans/m.^{3}. Another incident occurred when the dust of PbO from a factory making Ironclad batteries for submarines was spread on the surrounding meadows. This caused collective toxemia of the grazing animals with the death of 3 cattle. In Ravenna anhydride of S (SO_2?), H_2SO_4, nitrous gases, complexes of HCl-fluoride of Si, phosphorite dust and perphosphate dust were emitted from a chemical plant. They caused irritation of the upper respiratory tract, particularly the larynx and trachea, with resultant cough, troublesome respiration and a feeling of suffocation, but no serious injury in human beings. Animals suffered considerably more and there was severe damage to plants and property attributed to F. Complaints have also come from the industrial area around Apuania, on the Tyrrhenian Sea, where chemical industries had begun operations about 1931. Pollutants include coal dust, Ca dusts of all sorts, nitrous and NH_4^+gases, SO_2, H_2F_2, SiF_6,CO,etc. Towns involved were Massa and Ferrara. Data gathered by authorities had not given proof of effects on man or animals, although complaints had been frequent. Several other communities, where complaints had been made because of activities of chemical plants established around 1920, e.g., in Porto Mar Marghera, Mestre and others, are incited. Also, a metallurgical plant in the Aosta Valley where increased incidence in pneumonia has been reported is cited. The psychic and neuropsychic aspects are again mentioned. It is suggested that maximum publicity be given to the control of pollution.

384. Pybus, R.C.: Cancer research - a review. Ann. Roy. College Surgeons England 17:184-93, 1955.
A history of the study of cancer and the development of strains of mice for this study are presented. Benzpyrene has been shown to to be a universal carcinogen and to be present in smoke and soot which are quite abundant in city air. The deposit of soot in the lungs of town dwellers has long suggested it an obvious cause of lung cancer. Also soot deposited on the skin may lead to absorption of the adsorbed material and distribution to internal organs. 204 tons of atmospheric deposits/sq. mi. or 3,346 tons over the whole city was estimated to have fallen on Newcastle in 1952. The tar content of this amount was estimated at 25 tons. The

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Pybus, R.C. (continued)
average benzpyrene content in Sheffield is 4.2 μg./100 m.^{3}, which would mean that a person would inspire 1.64 mg. in 10 yrs. and 5 mg. in 30 yrs. 5 mg. benzpyrene injected in mice was found to produce 100% tumors and 0.125 mg. gave 75% tumors but with a very much longer latent period. Other important factors besides atmospheric pollution in carcinogenicity are: smoking, motor exhaust fumes and dyes in foodstuffs. It is believed that lessening of atmospheric pollution would help greatly to reduce the incidence of cancer.

385. Schepers, G.W.H.: Industrial asthma and bronchitis. Ind. Med. Surg. 24:53-61, 1955.

The author discusses morbidity and mortality due to bronchitis and asthma in relation to occupation. There are many occupations involving dust exposures in which bronchitis or asthma or both characteristically occur. Some examples are workers in the cotton, sugar, cereal and printing industries, brewers, haymakers, woodworkers and fur handlers. Chemical bronchial disease is often encountered in industries where fumes of metals or their salts or of some organic chemicals are constantly inhaled by the workmen. The relationship of irritant gases, such as those used in World War I, and of other gases, e.g., NH_3, HCHO, N_2O, NO_2 and SO_2, to these diseases is discussed. Many of these irritant substances, particularly metal dusts, have been demonstrated in city atmospheres and, no doubt, affect the general health. Smoky and dusty environments are often related to bronchitis studies. The relation of bronchitis and asthma to the pneumoconioses is also discussed.

386. Schrenk, H.H.: Pitfalls in maximum allowable concentrations in air pollution. Am. Ind. Hyg. Assoc. Quart. 16:230-4, 1955.

The information and criteria used in establishing maximum allowable concentrations and the application of these limits in general are discussed. Analysis of the stress of air pollution shows a complex mixture of gaseous and particulate matter which is ill-defined. Both composition and concentration vary widely and cannot be controlled. An analysis of the resistance of exposed population shows that this also is a variable in which all types of people are exposed and which cannot be adequately described. This is not true in industrial exposure for which MAC's were determined. Here, an analysis of the stress usually reveals a single well-defined agent is involved that can be controlled as to concentration and time of exposure. An analysis of the resistance of industrial population to such a stress shows that a select group of adults in relatively good health is involved. However, intelligent interpretation and utilization of available toxicological information and experience accumulated in the fields of industrial hygiene and industrial medicine can contribute to a better understanding of the air pollution problem and serve as a guide in the development of the research programs which are essential to a sound evaluation of the chronic effects of air pollution on health.

387. Seamans, F.L.: Legal aspects of air pollution. Proc. 3rd Natl. Air Pollution Symposium, Pasadena, Calif., April 18, 19, 20, 1955: 221-4, 1955.

The legal basis for control is common law which is briefly discussed. 8 fundamental concepts for air pollution legislation are

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Seamans, F.L. (continued)
stated. Basically existing legislation follows 1 or more of 3 types: (a) authority is given to make a survey or study, (b) a state law is passed enabling a lesser political entity to provide the mechanics for control or (c) control legislation itself is passed. Future legislation will be more restrictive, but it will also be based on a firmer scientific determination of what it is that is causing the complaints which basically led to the enactment of the control legislation. Evidence in damage cases is also discussed; it oftentimes is quite difficult to establish evidence for alleged injury to vegetation, livestock or human beings.

388. Stanford Research Institute, in co-operation with the California Institute of Technology, the University of California and the University of Southern California:
Proc. 1st Natl. Air Pollution Symposium, Pasadena, Calif., Nov. 10, 11, 1949, 149 pp.;
Proc. 2nd Natl. Air Pollution Symposium, Pasadena, Calif., May 5, 6, 1952, 144 pp.;
Proc. 3rd Natl. Air Pollution Symposium, Pasadena, Calif., Apr. 18, 19, 20, 1955, 229 pp.

389. Symposium: air pollution control. Rutgers Law Review 9, No.4:607-81, 1955.
Foreword: air pollution control, pp. 607-8.
Cowan, R.A.: Air pollution control in New Jersey, pp. 609-33.
Air Pollution Control Act (1954), pp. 634-9.
Moran, G.R.: The air pollution control act and its administration, pp. 640-81.

The present day realization of the desirability for air pollution control is briefly discussed in the foreword. The first main article, "Air pollution control in New Jersey," is a "general examination of the practical, legal and technological problems inherent in the control of air pollution." It discusses the general problem under the topics of type and sources of pollutants, detection and measurement, effects and, more particularly, air pollution in New Jersey. It next discusses the prior laws on the subject which include the common law of nuisance, municipal ordinances and statutory law. The (N.J.) Air Pollution Control Act (1954) is then printed in full. The last article is an introductory "inquiry into problems legislatively anticipated or likely to be encountered in the administration of the Air Pollution Control Act and into the provisions of this Act and of other laws which should guide solution of those problems." The topical headings include background, framework and constitutional matters; guides to interpretation, relations to other laws; research and education; the commission, county association, rule making and rules; from rules to desist orders and proceedings in court: review and enforcement.

390. Turk, A.: Odor control methods: a critical review. Ind. Med. Surg. 24:177-82, 1955.

The 4 general odor control methods, viz., combustion of odorants in air, adsorption, absorption and vapor mixing are critically reviewed as to the equipment used and the application and limitations of each method.

391. U.S. Congress, 84th. Public Law 159: An Act to Provide Research and Technical Assistance Relating to Air Pollution Control. Chapter 360, 1st Session, S.928, 1955.

The purpose of the Public Law 159, Chapter 360, which was passed in the first Session of the 84th Congress and approved on July 14th, 1955, is to provide research and technical assistance relating to air pollution control. It is divided into 7 "Sections" which may be summarized as follows: 1) Congress will preserve and protect the responsibilities and rights of States and local governments as well as of local public and private institutions and agencies with respect to research on and control of their air pollution problems. The authority for the execution of this law is given to the Secretary of Health, Education and Welfare and, under his supervision, to the Surgeon General (S.G.) of the Public Health Service. 2a) In cooperation with both Federal agencies and those referred to in Section 1), the S.G. may conduct investigations serving to establish research programs designed to develop air pollution control methods. 2b) The S.G. may encourage cooperation between the agencies referred to above, collect and disseminate pertinent information, conduct in the P.H.S., and support the conduct by agencies, etc. under Section 1), of technical research in prevention and abatement of air pollution; make available to agencies, etc. under Section 1) all results obtained therefrom. 3) The S.G. may, upon request of any of these agencies, conduct investigations on and recommend solutions of any specific related problem. 4) The S.G. shall, at regular intervals, publish reports and recommendations with regard to the air pollution control program. 5) The Department of Health, Education and Welfare shall receive, for the period beginning July 1, 1955 and ending June 30, 1960, 5 yearly allotments not surpassing $5,000,000 to carry out its function as described in Section 1), in order to a) make grant-in-aids to, and b) enter into contracts with the agencies referred to, with the aim of sponsoring research, training and demonstration projects. These sums will be allotted by the S.G. 6) This Section defines the terms "State air pollution control agency" and "local government air pollution control agency" as designating, when used in this Act, the respective State or local health authorities, except in cases where special air pollution abatement agencies have been instituted. The term "State" stands for a State or for the District of Columbia. 7) This Act does not limit the authority of the U.S. departments and agencies to make and conduct grant-in-aids or contracts for research and experiments related to the air pollution control problem.

392. Watkinson, E.A.: Associated health implications in air-pollution control. In: Mallette, F.S.: Problems and Control of Air Pollution. Proceedings of the First International Congress on Air Pollution held in New York City, March 1-2, 1955 under the sponsorship of the Committee on Air-Pollution Controls of The American Society of Mechanical Engineers. N.Y., Reinhold Publishing Corp., 1955, Chap. 8, pp.69-73.

It is suggested that a distinction should be made between such well-known air pollution incidents as the Meuse Valley, Donora, Poza Rica and London. Instead of considering these occurrences as an example of a general type of situation which may arise, perhaps it would be sounder to recognize that the London episode of Dec. 1952, as contrasted with the others, represents a different type of situation which may be termed "typically urban." In the opinion

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Watkinson, E.A. (continued)
of the author, the problem presented by a number of major cities is this relatively featureless type of pollution. While fairly well defined damage to the human body can be associated with the acute effects following exposure to high concentrations of many toxicants, unfortunately this evidence is of little value in determining the results of long exposure. Possibly more definitive correlations might be obtained from properly designed surveys. Investigations of the Windsor-Detroit type represent one approach in solving some air pollution problems. Other hypotheses which have been advanced to explain the unaccountably high irritant and toxic properties of urban smogs are those of synergism, adsorption and solubility. These, however, require further investigation and particular attention should be paid to the design of the experiments. Owing to the lack of basic experimental data, the knowledge of the health implications of these concepts is still beyond reach at the present time and the final answer is dependent, in part, on work yet to be performed. (Modified author's summary.)

393. Weil, G.L.: Hazards of nuclear power plants. Science 121: 315-7, 1955.
A realistic appraisal of the future of nuclear power must include consideration of the potential problems as well as the potential benefits. The discussion presented is focused on the hazardous conditions that could, under the most pessimistic assumptions, result from a major accident involving a nuclear power plant. These hazards include: (1) irreparable destruction of the reactor and building; (2) lethal effect on a large fraction of plant personnel; (3) under the worst conditions of transportation of a dust cloud, lethal doses of radiation, temporary or permanent injury and food and water contamination at a distance from the plant and (4) psychological effects. Plants should be designed, as far as possible, with these maximum effects in mind. Possible recommendations include: (1) selection of the most stable basic reactor; (2) location in a remote, unpopulated area; (3) location on a large site; (4) gas-tight design of the reactor building; (5) continuous removal of fission products, when liquid fuels are used and (6) a widespread warning system and means for rapid evacuation or sheltering of personnel. The 2nd recommendation is impractical, the 3rd expensive, the 5th practical to a certain point and the 4th the most promising. The past 12 yrs. of safe activity is convincing testimony to our understanding of the technology and encourages us to believe that the problems of the future can be met with equal success. (Abst. Ind. Hyg. Dig. 19:583, 1955.)

394. Woodward, R.L.: State air pollution control activities. Public Health Repts. (U.S.) 70:433-6, 1955.
There has been a marked increase in interest in air pollution and in activities aimed at its control. The problem has been traditionally considered one for local action, but state assistance is needed to finance control in many places and to deal with problems when local control agencies are nonexistent or powerless to act because of lack of jurisdiction. The air pollution control activities of Ore., Mass., N.J., Md., Pa. and Wash. in particular are reviewed. Most of the other states have more limited programs.

395. Anonymous: Fog. Lancet I:95-6, 1956.

The fog that covered many parts of England during the first week of January, 1956, had no appreciable effect on mortality and morbidity. It was much less severe than that of 1952. Very few fog casualties were reported in London. In order to cope with any emergency, the Medical Research Council had taken special precautionary measures, particularly with regard to the availability of hospital beds.

On Christmas Eve, general practitioners, pediatricians and Public Health Officials in the Liverpool area reported an epidemic outbreak of respiratory infections among children, most of them being < 18 mo. but some being > 2 yrs. old. Although the disease was initially diagnosed as acute bronchitis, bronchiolitis or pneumonia, it was later felt to be a virus infection. Up to Jan. 9, 1956, there were 230 known cases in Liverpool, 100 in Sunderland.

The information provided in the Registrar-General's Statistical Review of England and Wales, 1954, deals with deaths from all causes and with the incidence of infectious diseases in 1954 with special mention of age, sex, area of residence and time of yr.

396. Anonymous: How air pollution affects health. New approaches now are being used to study the response of humans to contaminants in the air. Chem. Eng. News 34:4824, 1956.

Several of the studies on the effects of air pollution on health are reported. In the project at the University of Cincinnati, reported by Dr. Carey, the medical history of a group of 30 patients living in a smoky area of the city is being carefully followed and the clinical findings are compared with continuous measurements of atmospheric conditions in the patients' homes. At the University of Southern California, Hans Falk and Paul Kotin, working with animals, have found that other factors in smog, besides inhalation of cancer causing agents, play a role in lung cancer by adversely affecting the respiratory system. Some irritants, e.g., oxidized aliphatic hydrocarbons, harm certain defense mechanisms, e.g., movement of the cilia and secretion of mucus. D.M. Pace of the University of Nebraska has been investigating the action of single smog constituents, e.g., SO_2 and NO_2, on cell growth, metabolism and morphology by the use of tissue culture. Another method, suggested by T.W. Kethley of Georgia Tech, is the use of air-borne microorganisms as analytical tools in aerosol studies. Despite all the studies that are being undertaken, much help is needed for everything that still remains to be done.

397. Anonymous: Lung cancer. Cincinnati J. Med. 37:273-4, 1956

This is a short review of information reported by Dr. C. A. Mills as resulting from his investigation in Cincinnati of the major factors associated with the incidence of and death rates from lung cancer. In the study, the significant influence of tobacco smoking and inhalation of motor exhaust fumes was demonstrated. According to Dr. Mills, the latter will increase the tendency of the urban population to move to suburban or rural areas. Quite different from infectious diseases, which usually are followed by complete tissue recovery, each nonfatal exposure to polluted air causes irreversible, irreparable cell damage in the respiratory system which accumulates with repetition. Therefore, the immediate injurious effects are

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Anonymous: Lung cancer (continued)
no longer a criterion, and a new evaluation of the MAC established previously is imperative. Persons living in polluted urban atmospheres and/or regularly driving should reduce or, better, give up smoking. Also, the use of afterburner-type exhaust mufflers or improved combustion in the cylinder chambers, as are anticipated for use in Los Angeles in the near future, could greatly contribute to decrease the pollution of the air due to exhaust fumes given off by motor vehicles.

Under standard conditions of age, sex and air pollution other than tobacco smoke, the degrees to which certain factors may increase the incidence of lung cancer are predicted. No increase in the occurrence of pulmonary cancer has been observed due to even extensive driving in rural areas.

398. Anonymous: Pollution control can be wasteful. Chem. Eng. News 34: 3038, 1956.

According to R. W. Hess, coordinator of air pollution research for National Aniline, public interest in and concern about the pollution of both water and air have resulted in many beneficial State and Federal regulations and laws, but also in some efforts that have to be considered unsound from the scientific, economic and social points of view. Complete pollution control is not feasible and would impose unbearable economic burdens. Some waste constituents may, by themselves, regain their natural state. Frequently, wastes can be favorable for certain uses of resources - as can be natural H_2O components - with or without being unfavorable to others. As examples, the following are mentioned: dissolved O_2, Ca salts, NaCl in H_2O which are essential to many fish but not advantageous or even harmful for various industrial or chemical uses. Intelligent and effective control of pollution should yield a minimum amount of waste and should aim at recovery and economical use of the waste material, as it is accomplished in distilleries and in corn industries, in the recovery of vitamin B_{12} from sewage sludge, further in the recovery of HCl from organic chemical chlorinations or of S from smelter fumes. Much research is still needed in this field, particularly as regards colloids, enzymes, supersonics, nuclear energy and radioactive tracers.

The value of this research might not be as tangible as that of developing new production methods, but it will aid in the wise spending of the large sums involved.

399. Anonymous: Report on atmospheric pollution. Lancet I:43, 1956.

This is a review of a report on atmospheric pollution in Great Britain, recently published by the Department of Scientific and Industrial Research, containing evidence of some decrease in the pollution of the air caused by smoke and S oxides. >1,000,000 air analyses have been carried out in the last 10 yrs. by authorities amounting in number now to 220 as compared with 80 previously and by means of nearly 2,000 instruments. The results are summarized and evaluated in the report.

In urban areas, the contamination of the atmosphere may be 40 X that of rural areas. Smog may bring about an increase in pollution of 10 X that prevailing in normal times. More measuring instruments should be installed in rural areas in order to determine the distant effect of exhausts, and more daily recording instruments

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Anonymous: Report on atmospheric pollution. (continued)
should be made available for these studies.

To an increasing degree, the public is informed about the individual pollution factors, and this knowledge will probably influence building schemes. It is suggested that the effect of air pollution reduction on the incidence of respiratory diseases be studied by "making smokeless" one or several towns.

The expansion of investigations of this nature, principally concerned with the study of chemical, meteorological and medical factors, is largely due to the air pollution committee under the chairmanship of Sir Hugh Beaver, which had been established after the 1952 fog. It has greatly been assisted in its work by the Department of Scientific and Industrial Research.

As the main problems under investigation, the following are discussed:

a) the discharge of SO_2 into the air at rates of $> 5,000,000$ tons/yr.,

b) the burning of 1,000,000 tons of coal/yr. by each of the large electricity-generating stations,

c) the possibility of reducing the smoke hazards and of better utilizing the coal by equipping the hand-fired boilers still in use with smoke-eliminator doors.

The last part of this review enumerates numerous other pertinent air pollution problems dealt with in the Department's report.

400. Brieger, H.: Synergistic and antagonistic effects of mixed air contaminants. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, pp. 7B-8B.

Synergistic and antagonistic effects of mixed atmospheric contaminants may originate from various processes in the environmental air within the body. Interactions and reactions in the air which may produce irritation and/or intoxication not caused by the individual contaminants alone are discussed by other speakers. The interaction of liquid and solid aerosols and the utilization of pertinent experimental findings are briefly presented in this paper. Observations of physiologic reactions to contact with or absorption of combinations of air contaminants are reviewed, with special reference to mixtures of benzene and its homologs and chlorinated hydrocarbons (solvents). A new experimental method for the dispersion of mixtures of physically different agents and the statistical approach to the problem are described.

401. Falk, H.L. and Kotin, P.: Chemical and biological considerations of atmospheric carcinogenic agents. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 10B.

Two types of carcinogenic air pollutants are under discussion which differ in chemical, physical and biological properties. Both when present in the atmosphere can affect each other and consequently alter their carcinogenic effect on the target tissue. Ozonized aliphatic hydrocarbons induce tumors in the alveolar linings of the lungs of mice which differ from the typical bronchiogenic carcinomas found in man. The types of reaction product, be it peroxides, peracids, epoxides or free radicals, responsible for the carcinogenic action have not as yet been determined. Polycyclic aromatic hydrocarbons enter the lungs adsorbed on soot and are deposited at favorite bronchiogenic carcinoma sites. However, normal ciliary action

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Falk, H.L. et al. (continued)
and mucus secretion remove the larger part of the PM from the lungs in a few days. The importance of irritants such as oxidized aliphatic hydrocarbons is pointed out, as these compounds interfere with ciliary movement and cause the accumulation of soot in the lungs. In addition, these products elute the aromatic hydrocarbons from the soot, freeing them for carcinogenic action, and to some extent destroy their activity by oxidation. The rates of elution of hydrocarbons from soot and the rate of removal of soot from healthy and impaired lungs are being studied.

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402. Goldman, A.: The odor phase of air pollution. Ind. Wastes 1:217-20, 1956.
Odor cannot be considered seriously as a health menace, but has a high nuisance value and can cause damage to property or at least to property value. Methods of evaluation and abatement of odors are discussed. The nose is the only satisfactory means for detection of odor. The osmometer is the most used instrument for measurement of odor, but it depends upon perception by the nose. Odor surveys can be made by at least 7 persons making and recording independent observations. A distinction is made between masking and counteraction of odors. In masking, strong odors tend to mask weaker ones. Both may be perceived or the stronger odor alone may be observed. In counteraction, certain pairs of odors in proper concentrations are antagonistic and the intensity of each odor is diminished. Principles of odor dispersion are discussed. Location of an odor can be established only by field surveys. The use of counteraction in the gas warning agent problem and in meat rendering plants is discussed, and methods are described.

403. Hoffstaedt, E. G. W.: Atmospheric pollution. Lancet I:163, 1956.
The author disagrees with the opinion that the considerable pollution of the air originates only in smoke from industries and domestic coal fires. He enumerates various other sources of contamination both outdoors and indoors, such as exhaust fumes from motor vehicles, particularly from diesel engines in vans and buses, or tobacco smoke in buses and enclosed rooms. It is suggested to devise decontaminators to be fitted to the exhaust pipes, in order to absorb the escaping hydrocarbons, CO and other toxic constituents, and also to turn off, rather than idle, the motor when waiting in traffic lines. Furthermore, the author recommends air sampling and research into the tobacco smoke pollution of the air, reduction of coal smoke by application of most recent technological knowledge and the creation of smokeless zones.

Some effects of tobacco smoking on both smokers and nonsmokers are mentioned.

404. Hueper, W.C.: Environmental causes of lung cancer. Public Health Repts. (U.S.) 71:94-8, 1956.
There are a number of general environmental and specific occupational air pollutants causing cancer of the lung. Only some of the environmental pollutants are known, e.g., various mineral and road dusts, exhaust gases, petroleum vapors and soot. There has been a marked variation in the onset, degree and progression rate of lung cancer in different countries and localities. In Denmark, Norway and Italy, a rise in lung cancer death rates did not become apparent until after 1930, whereas this occurred soon after 1900 in highly industrialized countries, e.g., Germany, Switzerland and England. Lung cancer death rates are higher in urban-industrialized areas than in rural areas in England, Germany, Austria and America. Insurance policies indicate that the rates are 30-50% higher in males from low-income groups engaged in manufacturing, mining, transportation than

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Hueper, W.C. (continued)
for white-collar workers and the self-employed. The annual lung cancer death progression rates in the U.S. were higher for 1914-30 than for 1931-44. One would expect the opposite if cigarette smoking were a major causal factor in lung cancer. The rise in lung cancer death rates parallels as closely, or even more closely, the rise in production and/or consumption rates of motor fuel, coal tar, petroleum products and several carcinogenic metals and minerals, or the construction of asphalted roads, than that of cigarettes. Occupational cancers of the respiratory organs provide conclusive evidence of the existence of industry- and occupation-related respiratory cancer hazards for members of well-defined worker groups having contact with specific agents. Experimental observations on various species of animals have confirmed the carcinogenic action of coal tar, pitch, soot, various mineral and petroleum oils, Ni and radioactive substances, whereas with tobacco tar, the experimental evidence is uncertain and indicates the presence of only mildly carcinogenic agents.

405. Jecklin, L.: Bleistaub und Lungenkrebs. (Lead dust and lung cancer.) Schweiz. med. Wochschr. 86:891-2, 1956.

In 1955, a total of 540,978 tons of gasoline was imported into Switzerland. This means that during the same period, 200,000-290,000 kg. of Pb, primarily Pb bromide, in form of dust of extremely fine particle size, have been given off into the air by way of car exhausts. The study reported here followed a publication of an article in a Swiss magazine on the correlation between the presence of exhaust gases and the incidence of lung cancer. Among various views on the subject, a personal communication by R.A. Kehoe is referred to. According to Kehoe, there is no relationship between an increase of Pb in the atmosphere and the incidence of pulmonary carcinoma. Pb compounds have been used in the treatment of cancer. Also, there are no data indicating that exposure to Pb in industry is accompanied by an increase in the frequency of lung cancer. Numerous autopsy findings on Pb contents of lungs of persons exposed or nonexposed to the inhalation of Pb show wide ranges, partly due to the difference in analytical methods. Jecklin has analyzed lung specimens from 5 persons having died of lung cancer and from 5 persons with normal lungs, using the colorimetric method (dithizone) as described by O.Högl and H.Sulser. The results demonstrate that there is no difference in Pb contents between cancerous lungs and lungs of persons having died from other than lung diseases. The values found (in mg./10 g. of fresh tissue) ranged from 0.010 in a gardener to 0.018 in an unloader, or, with respect to the two groups, from 0.011 and 0.018 in the cancerous lungs to 0.010 and 0.016 in the normal lungs.

✓406. Jecklin, L.: Untersuchungen über den Bleigehalt der Auspuffgase beim Benzinmotor. (Studies on the Pb content of exhaust gases from gasoline motors.) Arch. Gewerbepathol. Gewerbehyg. 14:626-30, 1956.

The use of Pb gasoline as motor fuel has been permitted in Switzerland since 1947. The "ethyl fluid," added to the gasoline as an antiknock agent, contains (in weight %): tetraethyl lead (TEL) 63.3, ethylene dibromide 25.8, ethylene dichloride 8.7 and coloring matter 2.2. In both Switzerland and Germany, gasoline contains 0.4-0.6 ml. of TEL or 425-640 mg. of Pb/l. In addition to soot and gases, the exhausts of cars running on such gasoline also contain $PbSO_4$, $PbBr_2$, $PbCl_2$, $Pb_2(PO)_4$ and PbO. Numerous investigations have been carried out in order to determine the Pb content of exhaust gases. In the study reported here, an Austin A-30 car, using 1 l. of gasoline /18 km. driving at 50 km./hr., was chosen for a series of 5-min. test drives. The amounts of Pb deposited on cellulose filters in a funnel attached to the exhaust pipe was determined colorimetrically

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Jecklin, L. (continued)
with dithizone. The values found for the Pb content of the exhaust gases ranged from 274 to 404 mg. Pb/l. of gasoline, the difference being due to the changes in speed. During 1955, a total of 540,978 tons of gasoline was imported into Switzerland. It is calculated that at least 290,000 kg. of Pb have escaped into the air with the exhaust gases in the course of that year. The Pb contents of air samples, taken at various locations, ranged from 7γ/m.^{3} of air in downtown Basel to 2γ/m.^{3} of air in a village. None of the samples was found to be completely Pb-free. In dust samples, the following ranges of Pb content were detected: from traces and 0.03 mg. Pb out of town to 1.2 mg. Pb/g. of dust in downtown Basel. If each g. of dust, having the specific gravity of 1.4, contains 0.6 mg. Pb, each m.^{3} will contain 840 g. of Pb. It is stated that the toxic effect of Pb when taken up through the lungs, is 10-100 times greater than when it is ingested. The minimum toxic dose for human inhalation of Pb has been established at 100γ/day.

It is recommended to discontinue the use of tetraethyl lead as anti-knock agent, or else to reduce the Pb content of exhaust gases by attaching filters to the exhaust pipes in order to absorb the escaping Pb.

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407. Kotin, P.: The role of atmospheric pollution in the pathogenesis of pulmonary cancer: a review. Cancer Research 16:375-93, 1956.

During the last few decades, there has been a marked increase in the incidence of and the mortality from pulmonary cancer. Like other neoplasms, it is initiated by several factors, of which atmospheric pollution and cigarette smoking have been regarded as the most significant. Their incrimination is discussed with regard to both nonpulmonary occupational cancer and lung cancer of occupational origin. The epidemiologic data are reviewed in the light of the variations among and within various countries (including urban-rural differences) and other aspects, such as age, sex, race and socioeconomic status. The interpretation of the epidemiologic information for selected countries by local investigators is reviewed. Occupational lung cancer, significant as denoting environmental lung cancer, has been caused by inorganic substances, such as Ni and Cr, as well as by organic chemicals, like combustion and distillation products of coal and petroleum. Other factors may include radioactive substances, asbestos, isopropyl oil, As, Fe, Be and chromates. Selected environmental factors, presented in graphic form, include the increase in state asphalt highways, motor fuel and fuel oil consumption, motor vehicle registrations and cigarette consumption, as well as the rise in the annual production and consumption of cancer-related industrial chemicals.

Certain deficiencies inherent in the available information are pointed out, such as the fact that some data deal with mortality rates derived from vital records, while others convey figures on the incidence of lung cancer obtained from necropsy records. Also, the correlation of the data with the period of introduction of the carcinogen into the environment, i.e., the aspect of the duration of latency, has frequently been neglected. In addition, the early reports on cancer mortality in the various parts of the world are not always dependable, partly due to the lack of standardized recording methods.

"A review of the factors relating atmospheric pollution to lung cancer both on the epidemiologic and experimental levels warrants its incrimination as one of the dominant agents etiologically associated with the increase in mortality from lung cancer now being reported in various regions of the world. Other agents, including the frequently accused excessive use of tobacco, appear to be capable of playing only a secondary role in the

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Kotin, P. (continued)
increase in lung cancer rates. They may conceivably act as promoting agents so that in the presence of a prepared or initiated soil they can act either synergistically, as additives, or as cocarcinogenic agents."

408. Lickint, F.: Grossstadtluft, Tabakrauch und Lungenkrebsanstieg. (Air pollution of large towns, tobacco smoking and lung cancer.) Med. Klin. 51:761-4, 1956.
It is generally agreed that there has been a real increase in the mortality from lung cancer, but not all authorities agree on the causes of this increase. Some believe that pollution of the air in the big towns is responsible for some of the increase, but in the author's opinion this is very doubtful. Pollution of the air with coal smoke has been common in England for centuries, but the increase in mortality from lung cancer began only ca. 30 yrs. ago. Motor fumes have not generally been found to induce a high mortality from the disease among men occupationally exposed to them. The higher incidence recorded in some big towns can be associated with a greater consumption of cigarettes; in Germany, however, the towns do not show a consistently greater mortality. It is also notable that the increase in mortality was first reported in nonindustrial Russia (where large numbers of cigarettes were smoked) and not, for example, in the Ruhr. If town smoke were to produce respiratory cancer, it is inconceivable that women, children and animals would not also have been affected. In the author's opinion the increase must, therefore, be attributed to certain well known specific industrial hazards and to tobacco. (Abst. Bull. Hyg. 31:1227, 1956.)

409. Magill, P.L., Holden, F.R. and Ackley, C., ed.: Air Pollution Handbook. N.Y., McGraw-Hill Book Co., Inc., 1956.
The contents of this book include 14 sections, titled as follows: 1) Air pollution sources and their control; 2) City planning, industrial-plant locations and air pollution; 3) Chemistry of contaminated atmospheres; 4) Physics of the atmosphere; 5) Evaluation of weather effects; 6) Visibility and air pollution; 7) The epidemiology of air pollution; 8) The effects of air pollutants on farm animals; 9) Effect of air pollution on plants; 10) Sampling procedures; 11) Analytical methods; 12) Experimental test methods; 13) Equipment and processes for abating air pollution and 14) Air pollution control by legislation. (See also Phair, J.J.,Abst. 412.)

410. Mallette, F.S.: Legislation on air pollution. Public Health Repts. (U.S.) 71:1069-74, 1956.
Today with ever-increasing air pollution, legislation is needed to help put a stop to it. Various laws regarding this have been passed since 1864. Examples of local, federal and state, and municipal and county control legislation are given. The cost of control also makes progress slow.

411. Newbury, B.C.: Some sources of error in air pollution measurement. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956,pp. 12B-13B.
Many of the data collected in air pollution surveys are of little value to other laboratories, because of lack of standardization of equipment and procedures. Parallel exposure of 2 types of dustfall collectors have shown one can to collect 2 $^1/_2$ times as much as the other. Dustfall data are meaningless unless the can design and exposure are specified. In the vicinity of a chemical plant the occurrence of "negative" SO_2 readings on Thomas Autometers was traced to NH_3 and most of the "high SO_2" readings

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Newbury, B.C. (continued)

were due to the fact that the NH_3 in the atmosphere was more than sufficient to neutralize the acid in the Thomas Autometer. Ion exchange resins are being used to remove NH_3 upstream of the conductivity cells. The progressive reduction in flow through high volume filters restricts the collection of aerosol toward the end of each day's run. This is often in the early morning, when aerosol concentrations are high, and this leads to an underestimation of the average level. An air-flow controller has been devised to keep the flow rate of a high volume sampler steady between 45 and 50 ft.^{3}/min. over 24 hrs.

412. Phair, J.J.: The epidemiology of air pollution. In: Magill, P.L., Holden, F.R. and Ackley, C., ed.: Air Pollution Handbook. N.Y., McGraw-Hill Book Co., Inc., 1956.

The proper control of air pollution in cities and industrial areas is needed. Past health hazards, e.g., problems of climate and disease hazards, have been met and solved. This must now be done for air pollution. "Pure air" is rarely ever found; what should be sought after is a "safe and tolerable air." The only acceptable objectives are the definition of pollution controls required in a given situation and justification for their use by appropriate health agencies. A comparison of air to water pollution problems and methods of disposal is made. Possible disposal methods are dilution in the atmosphere, trapping and treatment to produce a nonhazardous effluent. Theoretically, the causal relationship between air pollution and toxic effects could be proved by establishing these 4 points: 1) a toxic effect has occurred, 2) a pollutant capable of causing this effect is (has been) present, 3) there is (has been) an excessive exposure to the pollutant and 4) other causes of the toxic effect do not exist. These conditions are, however, too rigid and it is unlikely that they can be satisfied in the usual urban setting. They can, nevertheless, be used as a guide in obtaining evidence.

The present knowledge has been obtained from 3 sources. The first is industrial toxicology. The effects of in plant contaminants on workers have been studied and from these findings maximum allowable concentrations (MAC values) have been established. These values represent concentrations of substances to which workmen may be exposed during their work periods with a relatively low probability that undesirable reactions will follow. The principal trouble in this work is that most of the effort to quantify or anticipate human reactions to an industrial plant exposure has been based on animal reactions which are not identical with human ones. The field, however, has provided some certain information. The 2nd source of knowledge is information from unusual or accidental exposures, e.g., the Meuse Valley, Donora and London episodes and the more defined exposures to H_2S in Poza Rica, Cl_2 in Brooklyn and Hg in a Hg mine. These are extreme examples of pollution and the amount of useful knowledge for understanding chronic exposures is small. Excess morbidity and mortality rates have provided a 3rd source. Such rates have been compared with sootfall data in some areas for correlation purposes, but important variables, e.g., age, sex, occupation, socioeconomic factors and environmental conditions were not corrected for. In such studies, there is no clear-cut and established disease entity known for the numerator and no constant socioeconomic factors, environmental conditions or host habits to form a denominator. It is believed that air pollution hazards in community studies can be measured only by a longitudinal morbidity survey related to the degree and kind of air pollution.

413. Rogers, L.H., Renzetti, N.A. and Neiburger, M.: Smog effects and chemical analysis of the Los Angeles atmosphere. J. Air Pollution Control 6:165-70, 1956.

For the information contained in this article see abstract: Renzetti, N.A., (ed.): An Aerometric Survey of the Los Angeles Basin August - November, 1954. Report No. 9. Los Angeles, Calif., Air Pollution Foundation, 1955, 333 pp.

414. Schrenk, H.H.: Quantitative aspects of air pollution in relation to health. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N. J., Sept. 16-21, 1956, p. 7B.

To establish a meaningful evaluation of the effects of air pollutants on health, it is necessary to have a quantitative measure of the offending agents and means of determining the magnitude of response, if any. An analysis of the environmental stress reveals a complex mixture of gaseous and particulate matter which varies greatly in both composition and concentration from place to place and time to time. Existing data show that significant concentrations do not exist continuously 24 hrs./day but rather consist of a series of episodes of infrequent occurrence and indefinite periods of duration which exceeds a level that can be accepted as having no effect on health. An analysis of the effects of air pollutants indicates that the response is not specific in character but simulates other disease entities and conditions. In addition, the exposed population ranges from the strongest to the weakest, including the highly susceptible. Hence, precise appraisal of response is difficult. However, these are the facts which must be evaluated and intelligently interpreted in order to provide meaningful data on the quantitative effects of air pollution on health.

415. Thomas, M.D.: Air pollution review 1954-1955. Ind. Eng. Chem. 48:1522-7, 1956.

This is a review of the air pollution literature published in 1954-1955 exclusively. Many symposia were held in these 2 yrs. Papers on analytical methods and results are discussed under the following headings: oxidants, oxides of N, C compounds, reduced S compounds, odors, the sky scanner, aerosols, engineering, chemistry of Los Angeles smog and auto exhausts. The last section reviews the literature on air pollution and health. (96 references.)

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416. Torrance, J.: The epidemiology of lung cancer in New Zealand. Lancet I:286-7, 1956.

This letter to the editor is part of a controversy concerning the incidence of lung cancer in general, and in New Zealand in particular, and the factors principally responsible for it. (See abstracts Eastcott, D. F., Lancet I:37-9, 1956; Joules, H., ibid., 163.) The author rather agrees with Eastcott's evaluation of the causal or contributing factors of the disease and feels that there is no justification for blaming the high increase in lung cancer incidence solely on cigarette smoking. It seems unlikely that, for instance, the fact that the death rate from lung cancer among males of the age group 45-54 yrs. in England is 3 times that recorded in New Zealand, should only be due to a cigarette consumption 3 times that of the former group. Since the total tobacco consumption/person is about the same in both countries, one should conclude, by the same reasoning, that New Zealand's inhabitants have smoked 3 times as much pipe tobacco as the average Englishman. The differences in the occurrence of lung

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Torrance, J. (continued)
cancer not only between native-born New Zealanders and immigrants to that country from the United Kingdom, but also within these 2 groups, is not explained by differences in their smoking habits. The factor of cigarette smoking must definitely not be overlooked in the etiology of lung cancer, but it cannot be considered the only factor involved. The possibility of a synergistic effect between smoking and air pollution is mentioned.

417. Vorwald, A.J.: Biological effects of air pollution. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, pp. 9B-10B.

The biological effects of an air pollutant are functions of a number of variable and interrelated factors which may be grouped in two separate categories. One group of factors pertains to the pollutant per se, especially its physical and chemical characteristics, its concentration in the atmosphere and its capacity to irritate the tissues of the body. The other group relates to the individual exposed to that pollutant, specifically the manner and length of his exposure, his susceptibility or resistance to the pollutant, his age, sex and general health status. These factors are discussed.

SEE ALSO: Meller 38; Roffo 40; Lanza 59; Schueneman 64; Largent 74; California Dept. Health 177; Fowler 187; Dreyfus 454; Stokinger 527; Dautrebande 530; Greenwald 572; Kotin 585; Randig 592; Am. Conf. Govtl. Ind. Hyg. 595; Pattle 601; Weedon 641; Haagen-Smit 694; Kotin 714; Stokinger 723.

III STUDIES ON THE INDIVIDUAL --

Reports of Effects of Occupational Exposures to Substances That May Occur as Atmospheric Contaminants; Experiments on Human Subjects.

418. Binz, C.: Ozonisirte Luft, ein schlafmachendes Gas. (Ozonized air, a narcotizing gas.) Berl. klin. Wochschr. 19:17-21, 1882.

Two adult and one 12-yr. old male subjects were exposed to the inhalation of ozonized air for 20, 35 and 18 min., respectively. (The technic as described in another paper (Ibid. 19:6-8, 1882) involved the passage of O_3 from a Siemens apparatus to face masks worn by the reclining subjects.) In none of the subjects was sleep induced, but all felt slight pharyngeal irritation. A sensation of lightness was caused in the adults and a mild headache in the boy. Thus, considering all 6 human subjects (including 3 reported in earlier paper) exposed to the inhalation of ozonized air, sound sleep was produced in 2, superficial sleep in 1, various degrees of cerebral depression, at times accompanied by signs of excitation, i.e., by occasional facial spasms or pharyngeal irritations in 5. Higher concentrations of O_3, however, may cause severe cough, choking and vomiting which was demonstrated in the effects of the exposure on the author and 2 other adult male subjects. The correlation of exposure concentrations and physiological effects of O_3 is compared with those of alcohol. It is stated that the experiments have demonstrated the necessity to follow precisely all points of the described technic if satisfactory results are to be obtained from experimental exposures to the inhalation of ozonized air. The caustic action of O_3 which had been reported elsewhere might have been due to some gaseous impurities. The processes $N_2O \rightarrow N_2 + O$ and $O_3 \rightarrow O_2 + O$ are compared which leads to a discussion of the question of how far these processes are completed before the gases reach the cerebrum. In order to study the action of O_3 on the blood, ozonized air at the concentration used during the experiments, was passed 4 X, 30-60 min. each, at 20-27° C. through samples of 500 cc. of defibrinated mutton or calf blood. Macro-, micro- and also spectroscopic examinations did not reveal any methemoglobin nor any other changes in the blood. The same exposure, but for 1 hr., of a mixture of 5 cc. of fresh rabbit blood and 5 cc. of 0.7% salt solution changed the color of the blood into a deep red which turned overnight to brown. The erythrocytes were round and enlarged but not destroyed, the latter fact being probably due to the protection by H_2O and the organic blood constituents. Again, as was true in the case of alcohol, the proportions are the deciding factor. The ozonized air was passed through a mixture of albumin and 80 cc. 1% solution of Na_2CO_3 and also through a 40 cc. high layer of defibrinated mutton blood. Within a few min., the evolving gas had colored a KI starch paper reddish and then deep blue, proving that it was not decomposed while passing through the organic liquids. Neither the author's nor other investigators' analyses of ozonized air had ever shown it to contain N_2O, to which "constituent" the narcotizing effect of the gas occasionally had been attributed. A young cat, upon being exposed to the inhalation of the ozonized air, reacted with the usual somnolence. Due to the instability and the short action of O_3 and the variations in susceptibility of human beings to the gas it appears unlikely that it will find wide practical application as a narcotic or anesthetic.

419. Binz, C.: Ozonisirte Luft, ein schlafmachendes Gas. (Ozonized air, a narcotizing gas.) Berl. klin. Wochschr. 19:645-8, 1882.

In order to supplement the information given in his previous reports, the author again exposed male human subjects (5 new and 2 previous subjects) to the inhalation of ozonized air. For this series of experiments, the O_3 was

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Binz, C. (continued)
produced in 2 Grove elements and a Kolbe tube, and the subjects inhaled in a sitting position, occasionally operating the ventilating balloon themselves. The possibilities of a hypnotic effect of the regular ventilations in 1 subject and of the sensation of heat in another being due to the direct action of O_3 upon the subject's skin were ruled out experimentally. All the reported information may be quantitatively summarized as follows: In 43 experiments, 12 different human subjects have inhaled ozonized air. In 6 instances, no reaction was produced, although 3 of these subjects had previously reacted with cerebral depression. Of the 37 other exposures, 4 did not cause depression but were followed by facial spasms and/or a marked sensation of heat. Summarized qualitatively, the results show that 3 subjects in 19 experiments demonstrated a striking reaction by early and deep sleep or dozing; 6 persons in 21 tests reacted to a moderate degree, 5 showed cerebral depression, 1 had spasms. In 3 subjects (3 experiments), no cerebral reaction was produced. The variations in the results are explained on the basis of a certain apprehension about the effects of the gas and about the expected narcosis, as well as of the allergic reactions to ozone shown by most subjects. Because of this sensitivity, the induction of sleep was impeded or made impossible. There were too few vasomotor reactions to permit any conclusions.

The mechanism of the action of O_3 on the cerebral cells is compared with that of the bromides, chloral hydrate, CHI_3 and other anions. Both the amount or concentration and the duration of exposure determine the degree of effect, i.e., a paralysis of the cerebral cells, ranging from slight to severe, can cause effects such as sedative, hypnotic, analgesic or anesthetic which are followed by a recovery of the cells after termination of the exposure, but destructive effects are not. The nascent O, resulting from the decomposition of the O_3 in the organism, causes similar effects. This was demonstrated by exposing a specimen of cerebral cortex to ozonized air. The action is modified by factors mentioned earlier. O_3 is well tolerated by the blood. In order to investigate whether the anesthetic effect is due to O, the action of O_3 on a frog nerve which was exposed but not dissected is being observed in an experiment which has not yet been terminated.

From the results of his experiments, the author concludes that O_3 may be of therapeutic value in cases of asthma, nervousness and insomnia, which often has been demonstrated by the beneficial effect of the air in the high mountains or in the woods which is rich in O_3.

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420. Lehmann, K.B.: Experimentelle Studien über den Einfluss technisch und hygienisch wichtiger Gase und Dämpfe. VI. Schweflige Säure. (Experimental studies on the influence of technically and hygienically important gases and vapors. VI. Sulfurous acid.) Arch. Hyg. 18:180-91, 1893.

The investigation reported here was carried out in a plant producing sulfite pulp by cooking of coniferous wood with $CaSO_3$ in aqueous H_2SO_3: 24 g. "free" H_2SO_3, 12 g. CaH_2SO_3/1. H_2O, the cooking time being 18 hr. The digester was 20 m. high, and windows and doors provided the only ventilation. The following temperatures were measured (C.): outside, -4°, 1st floor, 8-9°, 2nd floor, 25-29° and 3rd floor, 3-4°. Considerable emittance of SO_2, due to leakage, was noticeable throughout. Analysis of air samples, collected on 2 occasions with a time interval of 16 da., by the $Na_2S_2O_3$ method, gave the following maximum values of SO_2 (in volume %) for floors 1) and 3): a) 1 - 0.0142, 3 - 0.0367; b) 1 - 0.0315 and 3 - 0.022. No workers were exposed for prolonged periods of time on the 2nd floor. The following effects of the various concentrations of SO_2 on the author and 2 other persons not accustomed to the exposure to SO_2 are

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Lehmann, K.B. (continued)
described (SO_2 in volume %): 0.0065 - 0.0115, barely noticeable for 10-15 min., 0.014 - 0.0147, distinctly noticeable, producing no effects for 1/2 hr., 0.022, distinctly noticeable but tolerable and 0.0304, severely irritating to the nasopharyngeal mucosae within a few min., the effects diminishing after 10 min. (total exposure was 15 min.). No irritation of the eyes was noticed, no sequelae remained. For workers accustomed to the exposure to SO_2, concentrations of 0.03-0.04 were noticeable but tolerable and without irritating effects. 30-40 workers from both day and night shifts, ranging in age from 20 to 51, in duration of exposure from 1/2 to 8 yr., were examined. No complaints about or clinical signs of chronic effects on the following organs were found: respiratory system, eyes, gastrointestinal tract and teeth. No other changes attributable to the exposure under normal conditions were detected; however, there were some incidents of accidental exposure to high concentrations of SO_2, due to sudden leakage, which had resulted in burns, corrosions and pneumonia or bronchitis.

The author's recommendations were confined mainly to suggestions with regard to improvements in ventilation.

421. Ascher, L.: Die Einwirkungen von Rauch und Russ auf die menschliche Gesundheit. (The effects of smoke and soot on human health.) Deut. med. Wochschr. 35:585-6, 633-4, 1909.

In order to evaluate the influence of the inhalation of smoke and soot on tubercular and nontubercular disorders of the respiratory organs (T and NT, respectively), the author compared data on mortality due to these causes with regard to the following aspects: occupation, social standing, regional and age distribution. An examination of the statistical information shows that in England, the mortality from T and NT is higher in all occupations involving the exposure to coal dust, than it is in agricultural pursuits, which is especially true for NT. Only coal miners, probably due to better wages and resulting better social conditions, had a low incidence in T. In both England and Prussia, in all age groups and both sexes, the relationship between T and NT showed a marked shift, i.e., while there is a decrease in mortality from T, as from all other diseases, the figures for NT are rising constantly. Data on infant mortality showed an increase in NT of 500-600% in the course of 25 yr. in various industrial areas, as compared with rural regions, where infectious diseases exceeded all other diseases as a cause of death. In industrial areas, smoky cities showed a much higher mortality from NT than did textile industry regions, where T predominated. A constant decrease in age at death in people suffering from T indicated an accelerating influence of smoke and dust inhalation on the course of T.

Experimentally, several groups of rabbits were exposed for varying lengths of time to the inhalation of soot in both humid and dry air, then infected, together with the control rabbits, with Aspergillus fumigatus. Some animals were killed after varying periods of time; others were observed in order to examine the course of the disease and to establish the times of death. In all experiments, the animals showed a more progressive course of infection, shorter survival times and more marked physical changes. In addition to anthracosis, the experimental rabbits were found to have desquamative pneumonia.

The author concludes that both statistical and experimental data demonstrate that the smoke and soot contained in city air and given off by industries, when inhaled, reduce the resistance of the lung, causing a predisposition for acute pulmonary diseases and, moreover, accelerating the course of T. Examples of this are the continuous increase of acute pulmonary diseases in infants and the decrease in age at death of persons suffering from T.

422. Loeschcke: Beiträge zur Histologie und Pathogenese der Nitritvergiftungen. (Histology and pathogenesis of nitrite poisoning.) Beitr. pathol. Anat. u. allgem. Pathol. 49:457-75, 1910.

On the basis of 3 case reports, both the histology and pathogenesis of poisoning due to the inhalation of fuming nitric acid are discussed. 3 male workers, ranging in age from 41 to 55 yr. had been exposed, on their jobs, for about 2 yr., to the inhalation of fuming nitric acid (no concentrations given). Due to the severely irritating action of the gas, they frequently had to interrupt their work in need of fresh air. No other symptoms were apparent during work or in the evening, but during the night, severe dyspnea and vomiting occurred which led to the hospitalization of the workers. One of them died of pulmonary edema. The other 2 patients also had lung edema and cyanosis, yellow-colored expectorations and dark coloring of the blood on phlebotomy. Their blood contained oxyhemoglobin but no methemoglobin, and the body temperatures rose to 39° C. One of the patients became soporous and died 48 hr. after the last exposure, the other one died after 7 da. of croupous pneumonia, severe dyspnea and heart failure. The findings from autopsy and histologic examination, described in detail, may be summarized as follows: the direct action of the nitrite is demonstrated in the dilatation of the blood vessels. Evidence of the chemical changes in the blood are: the presence of oxyhemoglobin and, in liver, spleen and kidney, of hemosiderin. In the alveoli, there was either edema, combined with acute emphysema, rupture of septa and occasional elimination by desquamation and expectoration, or there was regeneration of the alveolar epithelium. As to the course of the clinical process, the desquamation of the alveolar epithelium, due to the inhalation of the nitric fumes, results in pulmonary edema and lobular pneumonia of nonbacterial nature of the alveolar walls. The nitrite, circulating in the blood, is excreted via both the gastroenteric tract and the kidneys and, in this process, damages the tissue. Necroses in liver and adrenal glands also occur.

423. Shingu, S.: Über die Staubinhalation bei Kindern. (The effects of dust inhalation in children.) Virchow's Arch. pathol. Anat. u. Physiol. 200:207-20, 1910.

On the basis of autopsy findings from 22 infants and children, ranging in age from 1 day to 9 yr., who had died of various diseases, the distribution of coal dust in, and its effect on the lungs of children have been studied. In addition to both macroscopic and microscopic examinations of the lung tissues, histologic studies were done on the bronchial glands of 10 infants ranging in age from 24 da. to 2 yr., 9 mo. The results may be summarized as follows: the lungs of all children >23 da. of age contained coal dust, in amounts not always proportional to increasing age. Initially, i.e., in very young infants, the coal dust retained in the alveoli is deposited in the cells of the lumina and epithelium. From the age of 2 mo. on, dust was also detected in the perivascular connective tissue, particularly in that surrounding smaller vessels, where it was consistently, and at increasing amounts, present in infants >4 mo., 10 da. of age. From the age of 5 mo. on, the amounts of coal dust deposited in both the alveolar lumina and walls were found to decrease. Instead, increasing dust concentrations were found at the following sites: in the perivascular, subpleural, peribronchial and interlobular connective tissues, in the alveolar ducts and their lymph nodes as well as in the lymph nodes between the bronchi and vessels. Coal dust deposits were also found in 8 of the 10 bronchial glands dissected. It was rarely enclosed in cells; in 2 instances, it was located in lymph nodes, mostly, however, between them and/or in the medullated fibers. In the specimens examined, the coal dust was found

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Shingu, S. (continued)
to be deposited "obviously" in both epithelial and migratory cells. The author states that there is no evidence supporting the claim of some investigators that the dust from the alveoli reaches the tissue directly, without passage through the cells.

424. Fieldner, A.C., Katz, S.H. and Kinney, S.P.: Gas Masks for Gases Met in Fighting Fires. U.S. Bur. Mines, Tech. Paper 248, 1921, 61 pp.
Under the heading of "Properties and Effect on Man of Various Products of Combustion" (pp. 8-11), the following substances are discussed: CO_2, CO, soot, tar and smoke vapors. Under the heading of "Other Poisonous and Asphyxiating Gases Encountered by Firemen," these substances are covered (pp. 11-20): oxides of N, SO_2, NH_3, Cl, illuminating gas, gasoline and petroleum vapors, gases from CCl_4 fire extinguishers, i.e., CCl_4, HCl and $COCl_2$.

425. Henderson, Y., Haggard, H.W., Teague, M.C., Prince, A.L. and Wunderlich, R.M.: Physiological effects of automobile exhaust gas and standards of ventilation for brief exposure. J. Ind. Hyg. 3:79-92, 1921.
In order to determine the extent of the toxic effect of CO and other exhaust gases from motor vehicles traveling through the proposed tunnels under the Hudson River between New York and Jersey City, the following experiments were conducted. In 32 experiments 9 men and 1 woman were exposed in a 6 $m.^3$ chamber to 2-8 parts CO/10,000 parts air for periods of 1 hr. Blood samples were drawn before, during and after exposure for CO analysis. Tension of CO in the lungs after leaving the chamber was also determined. Some experiments included exercise during exposure. None of the subjects had an appreciable headache after 1 hr. exposure to $\leq$4 parts CO, and only a slight headache at 6 parts. With 8 parts there was decided discomfort for some hours, though laboratory and desk work could still be accomplished. At 10 parts the subject was miserable and adverse to work for 5-6 hrs.; effects were still felt after 12 hr. It was found that during 1 hr. sitting at rest a man's blood never absorbs appreciably more than half the amount of CO which it would take up if he stayed in the atmosphere indefinitely. Inactive and small breathing persons absorb less. A man breathes about twice as much air when walking fast as when sitting still, and when hurrying or doing rather heavy manual labor he breathes 3 times as much, and under exertion even more. Elimination of CO occurs in 1-2 hr. or even longer, or roughly 30-50 %/ hr. The results of this experiment are plotted to show the rate at which CO may be absorbed and the amounts at which physiological effects may occur. The curve shows that when the concentration exceeds 6 parts CO/10,000 air, men doing hard work for even a short time will be unfavorably affected. It also shows that passengers in cars going through the tunnel in 10-15 min. will absorb very little CO, a safety factor which will afford ample protection for children and invalids.

426. Henderson, Y., Haggard, H.W., Teague, M.C., Prince, A.L. and Wunderlich, R.M.: Physiological effects of automobile exhaust gas and standards of ventilation for brief exposure. J. Ind. Hyg. 3:137-46, 1921.
Experiments to determine the toxicity of exhaust gases under more realistic conditions than were used earlier (Ibid. 3:79-92, 1921) were carried out in a 12,000 $ft.^3$ brick building. An old Ford car was placed in the middle, the engine idled and the exhaust gases effectively distributed to a concentration ranging from 5.5-6.8 % CO (average 6%). Excess gases were led outside. Groups of a dozen or more persons sat or moved about in this chamber for periods of 1 hr. The general condition of the subjects,

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Henderson, Y. et al. (continued)
particularly occurrence or absence of headache was noted, the lung air was sampled for CO tension 5 min. after exposure, and the effect of running up and down 4 flights of stairs was noted. A few typical reactions of individuals are given in detail showing the following results. When the time in hours X the concentration of CO in parts/10,000 air = 3, there is no perceptible physiological effect; when it = 6, there is just a perceptible effect; when it = 9, headache and nausea are induced; and when it $\geqq$ 15, the conditions are dangerous to life. If the volume of breathing is increased by exercise, even by slow walking, and correspondingly more by physical work, the rate of absorption of CO is increased proportionally. After return to fresh air, the elimination of CO through the lungs proceeds at a rate of 30-60% reduction of the blood saturation/hr. 2 U.S. Army artillery horses were exposed to $\geqq$2.5-5.0 parts CO for 1 hr. No symptoms were noted. Due to uneven distribution it is thought that the horses might have been exposed to CO concentrations greater than were sampled. Investigation of a number of small private garages showed that, even with ventilation, the employees frequently have slight headaches, and even more severe conditions ranging up to maniacal manifestations. Sampling of the air for representative concentrations was not successful. It was thought that conditions such as may occur in tunnels might be found in the taxicab driveway and stand below Grand Central Station, N.Y. Upon observation and testing it was found that the CO content occasionally reaches 2 parts/10,000 air, but the ventilation soon brings it down to <1 part. There have been no complaints from the public and taxicab drivers have had only occasional headaches after a line of cars stands for a long time with engines running. Experiments were also carried out on dogs, ca. 5 at a time, to compare the toxicities of pure CO, illuminating gas, exhaust gas from gasoline and exhaust gas from coal distillate. The concentrations were made high so that the CO content was 30-40 parts/10,000 air. It was found that in the exhaust gas from gasoline, CO is the only considerable toxic constituent; in the exhaust gas from coal distillate (benzol, etc.) and in illuminating gas, accessory toxic substances are present.

427. Welsh, G.A.: The effect of the inhalation of gases. J. Ind. Hyg. 2:328-31, 1921.
H_2SO_4 mist irritates the exposed mucous membranes as well as the thin epidermis on the face and on the back of the hands. A person gassed by an irritating gas complains of difficulty of inspiration, shallow inspiration with coughing spells, exertional dyspnea, palpitation, dryness and burning of the throat, throbbing at the temples, nausea and vomiting. (Abst. Heimann, H. et al., U.S. Public Health Service, 1950.)

428. Haggard, H.W.: Action of irritant gases upon the respiratory tract. J. Ind. Hyg. 5:390-8, 1924.
This discussion of the action of irritant gases on the respiratory tract includes the topics of chemical irritation and vital reaction; determination of locus of action; protective reflexes; relative seriousness of injury to different levels of the respiratory tract and the chronic effects. The relation between the physical properties of irritants and their site of action in the respiratory tract and subsequent symptomatology is tabulated for NH_3, HCl, HCHO, H_2SO_4, SO_2, Br_2, Cl_2, phosgene and N peroxide.

429. **Batchelor, R.P., Fehnel, J.W., Thomson, R.M. and Drinker, K.R.:** Clinical and laboratory investigation of the effect of metallic zinc, of zinc oxide, and of zinc sulfide upon the health of workmen. J. Ind. Hyg. 8:322-63, 1926.

Careful and detailed clinical and laboratory studies were made on 24 male workmen exposed over periods of time varying from 2-35.5 yr. to the inhalation of varying concentrations of Zn (3.7-0.088 mg./ft.^{3}) in the form of ZnO, ZnS or fine metallic Zn dust manufactured from Zn ore conspicuously low in Pb (under 0.05%) and low in Cd (under 0.01%) were made. The 24 men were confined to a hospital 1-2 hr. after a day's work for a period of 48 hr. During this time they were allowed a normal diet. The clinical examination included: weight changes during the period of employment, genitourinary disturbances, scalp, ears, eyes, nose, mouth, throat, chest, cardiovascular system, abdomen, extremities, spine and skin. Laboratory checks were: X-ray, 24-hr. urine and feces collections, urine and feces analysis regular and for Zn, and the blood picture including analysis for blood Zn. The workmen represented varying types and degrees of exposure to Zn. They were a vigorous and healthy lot of men, giving no histories of significant past illnesses and showing only such physical conditions as would be expected in any similar group of men of the same ages, of the same social status and doing approximately the same amount of physical work in an atmosphere with a moderate amount of dust, but with no exposure to Zn. This fact is especially significant, indicating as it does, that ill health ascribed to Zn, particularly the so-called chronic Zn poisoning, often referred to in the literature, is in all probability due to toxic impurities, e.g., Pb, Cd, As and Sb, which commonly contaminate Zn ores and not to Zn itself. Laboratory findings demonstrated that Zn workers absorbed and excreted Zn in amounts considerably over the normal and that they maintained constantly a blood Zn content slightly higher than normal, as follows:

Blood: normal avg. 0.0387 mg. Zn/100 cc.; avg. of 24 men 0.458 mg.Zn/100 cc.
Urine: " " 0.080 mg. Zn/100 cc.; " " " " 1.06 mg. Zn/100 cc.
Feces: " " 9.32 mg. Zn/24 hr.; " " " " 46.77mg. Zn/24 hr.

The authors state that it is apparent that normal amounts of Zn may enter and leave the body for years without causing symptoms or evidence, which can be detected clinically or by laboratory examination, significant of gastrointestinal, kidney or other damage.

430. **Wilson, E.D., Gates, I., Owen, H.R. and Dawson, W.T.:** Street risk of carbon monoxide poisoning. J. Am. Chem. Soc. 87:319-20, 1926.

Policemen at heavily traveled intersections in Philadelphia complained of symptoms of CO poisoning, i.e., headache, slight nausea and muscular weakness. Tests for COHb saturation made on 14 foot-traffic patrolmen after 8 hr. of duty in a crowded section of the city gave values ranging from 0-30%; 6 of them were between 20 and 30%. Another examination of 18 foot-traffic men gave values of from 0.91-2.28% by vol. CO, and values of the COHb saturation ranging from ca. 5-13%. It is concluded that there is a definite street risk of repeated or chronic slight CO anoxemia.

431. **Beck, H.G.:** The clinical manifestations of chronic carbon monoxide poisoning. Ann. Clin. Med. 5:1088-96, 1927.

It has been stated that CO, a product of many industries, ranks 2nd as a death-dealing agent. Certain occupations., e.g., working in garages, around blast furnaces, gas works, smelting works and firing gas engines

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Beck, H.G. (continued)
are particularly hazardous in chronic CO inhalation. Combustion sources in the home and in the streets give off much CO. The nature of CO gas is discussed. The severity and clinical course of the symptoms produced depend upon the concentration of CO gas, frequency and duration of exposure, temperature and humidity, physical exertion, health of the individual, admixture of other poisonous gases and individual susceptibility. In an attempt to meet the increased demand for O_2, because part of the hemoglobin is tied up with CO, the blood often contains an increased amount of red blood cells and hemoglobin. In 665 steel workers, the red counts ranged from 6,000,000-9,676,000 and hemoglobin content from 95-125%. In a large % of fatal cases of CO poisoning, the cause of death may be attributed to cerebral lesions, e.g., congestion of the meninges and brain substance, hemorrhage into and softening of the internal capsule, lenticular nucleus and adjacent structure. Pneumonia often follows as an immediate sequence to acute poisoning. The various stages of symptomatology in acute poisoning are described. In some cases, a delayed CO poisoning occurs. Severe chronic CO poisoning presents many of the same symptoms as the mild acute form. The most frequent are headache, dizziness, muscular weakness, disturbance of gait, parasthesia, breathlessness on exertion and nervous and emotional instability. The muscular symptoms are particularly pronounced. Several illustrative cases where the symptoms simulated ulcers, hyperthyroidism and pernicious anemia are reported. Diagnosis and prognosis are also discussed.

432. ✓ Drinker, P., Thomson, R.M. and Finn, J.L.: Metal fume fever: III. The effects of inhaling magnesium oxide fume. J. Ind. Hyg. 9:187-92, 1927.

Instances of febrile reactions analogous to those caused by breathing freshly generated ZnO fume are reviewed. The substances mentioned include ZnO powder, Cu (oxide?), sprays of compounds of Ag, Hg, Fe, Co and Sb and fumes from burned Cd. It is probable that the fumes from the burning of Fe, Ni and Al in the electric arc would also cause the same general type of febrile reaction.

Four men, A, C, D and J, were exposed to 16, 17, 10 and 5 mg. of MgO, respectively. A inhaled slowly (6 respirations/min.), breathing deeply for 4 min. The rest inhaled normally (ca. 19 respirations/min.) for 3, 2 and 1 min., respectively. Only A showed a positive reaction, although C had some malaise. The subjects also inhaled 26, 29, 17 and 15 mg. MgO, respectively, in a similar manner as above. This time A's response was unmistakable, with a definite febrile reaction and leucocytosis resembling those caused by the heavy metals. These reactions were not significant in the other 3. Although MgO produces fume fever much less readily than does ZnO, it is believed that severer doses than those taken in these experiments would result in severer reactions.

433. Drinker, P., Thomson, R.M. and Finn, J.L.: Metal fume fever: IV. Threshold doses of zinc oxide, preventive measure, and the chronic effects of repeated exposure. J. Ind. Hyg. 9:331-45, 1927.

From the results of 27 experimental inhalations of freshly generated ZnO participated in by 10 subjects, men and women, under laboratory conditions, a formula was derived for expressing threshold doses of ZnO in terms of fume concentration, length of exposure and rate of breathing. As a measure of the severity of the reaction, the maximum increase in oral temperature above the normal was used. The protocol of the experiments is tabulated in detail. It was found in a metallurgic plant that concentrations of 14 mg. of ZnO/m.^{3} (measured as Zn) produced no reaction in the average subject

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Drinker, P. et al. (continued)
after an exposure of 8 hr. and that, in laboratory experiments, 45 mg. could be tolerated for 20 min. In both instances, the ZnO was exceptionally pure. As preventive measures, it is suggested that high concentrations of ZnO fumes be avoided, that local exhausts with air filters and partial or total recirculation be applied and that respirators be used for brief, intermittent exposures when ventilation is not applicable. Physical examination of 212 brass founders by the U.S. Public Health Service showed that those who experienced attacks of metal fume fever were "apparently in somewhat poorer physical condition than those who were exposed to the fumes, but not affected by them." If the dosage of ZnO inhaled is insufficient to cause the fever, there is no evidence that daily inhalation of the fume does chronic damage. (Authors' summary.)

434. Drinker, P., Thomson, R.M. and Finn, J.L.: Quantitative measurements of the inhalation, retention, and exhalation of dusts and fumes by man. I. Concentrations of 50 to 450 mg. per cubic meter. J. Ind. Hyg. 10:13-25, 1928.

Suspensions of freshly generated ZnO fume (particles ca. 0.4 μ), of Kadox (a ZnO powder - particles ca. 0.15 μ) and of marble dust (particles ca. 0.3-6 μ) were set up in a 1,600 ft.^{3} gas cabinet. The subjects (19 in all) seated outside the cabinet, inhaled the air from within and exhaled through an electric precipitator into a 125 l. spirometer.

Details of 41 experiments (16 for ZnO fume, 9 for Kadox and 16 for marble dust) are given in tables and graphs showing the amounts inhaled, exhaled and retained by normal men and women. The concentration inhaled varied from ca. 50-450 mg./m.^{3}, the length of exposure from 5-40 min. and the rates of breathing from 6-18 respirations/min. The % retentions were 57±10.8 (standard deviation) for ZnO, 56±7.3 for Kadox and 54±9.2 for marble, with an average of 55±9.4 for all 3.

435. Koelsch, F.: Gewerbliche Vergiftung durch Acrolein. (Industrial poisoning from acrolein.) Zentr. Gewerbehyg. Unfallverhüt. 5:353-4, 1928.

The physical and chemical properties of acrolein are outlined and the work of Lewin and Iwanoff on acrolein reviewed. In human beings it produces burning of the eyes, flow of tears, conjunctivitis, cough and bronchitis. There are few reports of serious damage caused by acrolein in industry. The author discusses 2 cases of such poisoning. 2 mechanics were working inside a used oil transport wagon that had contained rapeseed oil. They were building a heating coil into it and did some welding. The temperature of the flame was ca. 1600°C. They worked in and out of it for ca. 2 hr. under poor ventilation. Both became ill immediately thereafter. One (53 yr.) suffered nausea, dizziness, loss of consciousness and severe air hunger. The next day he had a violent fever with a dry racking cough and pneumonic infiltration over the lower portions of both lungs. Fever continued with further pulmonary complications. Also pressure in the pit of the stomach and nausea developed ca. the 9th or 10th day. Urine was thick. Increasing collapse, dyspnea, falling of the blood pressure, decrease in cardiac force and severe pain in the sacral region occurred and death took place on the 15th day of illness. The patient had had stomach trouble within the past yr. The other worker (41 yr.) suffered headache, numbness, a feeling of vertigo, nausea, and some days later had a dry tenacious cough with whitish yellow sputum and numerous rales. Ten da. later he developed a flat, disagreeable taste originating in the stomach and pressure in the pit of the stomach. Respiratory symptoms gradually receded but the stomach trouble became more conspicuous. He was able to work again in 4 wk., but stomach disturbances were still present 5 wk. later. It is concluded that these cases were due to acute poisoning

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Koelsch, F. (continued)
by acrolein which had formed from the thermal decomposition of rapeseed oil. Irritation of the mucous membranes of the respiratory passages appears to be an acute injury from acrolein. The gastric disturbances in the 2nd case were probably from the irritation of the stomach mucous membranes from the acrolein vapors which were swallowed. Necessary precautions for the prevention of similar accidents are suggested. Although, under the circumstances of the episode, poisoning might also have been from H_2C_2, H_3P, CO and/or H_2CO_3, the causal connection between acrolein and the toxic effects seemed to be most clear-cut.

436. Sayers, R.R., Yant, W.P., Levy, E. and Fulton, W.B.: Effects of repeated daily exposure of several hours to small amounts of automobile exhaust gas. U.S. Public Health Service Bull. No. 186, 1929, 58 pp.

Six men were exposed in a 1,000 ft.^{3} chamber 4-7 hr./day over a period of 68 da. to gasoline engine exhaust gas-air mixtures containing 2, 3 and 4 parts CO/10,000 air. Exposure to 2 parts CO/10,000 parts air caused some subjects at rest or exercising mildly to experience slight but not discomforting symptoms in approximately 2 hr. and distinct frontal headaches of a discomforting nature in 3 1/2 - 4 hr. No symptoms of any type were experienced in more than 50% of the exposures, and no occipital headaches occurred in any subjects even after 6 1/2 hr. exposure. The blood attained 20% CO-hemoglobin (COHb) in 3 1/4 - 4 1/4 hr. and 25% in 5-6 hr., depending on the person and if he was resting or exercising mildly. 3 parts CO/10,000 air caused in some subjects at rest or exercising rather slight symptoms in <2 hr. and distinct frontal headaches in 2 1/2 - 3 hr. In >65% of the cases, distinct discomforting symptoms were experienced after 5 hr. exposure. 20% COHb was produced in the blood in 2 1/2 - 3 1/2 hr., 25% in 3-4 hr. and 30% in 4-5 1/2 hr., depending on the subject and if he was at rest or exercising. 4 parts CO/10,000 air caused in some subjects frontal headaches in 1 1/2 - 2 hr. A few occipital headaches occurred in 2 1/2 - 3 1/2 hr. At the end of 3 1/2-4 hr. >90% had distinct frontal headaches. The blood attained 20% COHb in 1 1/4 - 2 1/4 hr., 25% in 2 1/4 - 3 1/4 hr. and 30% in 3-4 hr., depending on the subject and if he was at rest or exercising. Although headaches tended to appear with a lower amount of COHb from exposure to the lower concentrations of CO, in general, frontal headaches just began in some subjects when the saturation reached 18-20%. A few distinct occipital headaches accompanied by vertigo occurred at 23-28%. Exercise, even though of a mild form, distinctly augmented the absorption of CO and caused symptoms to appear after shorter exposure. The rate of elimination of CO from the blood in a given period after exposure varied directly with initial saturation. A 30-min. inhalation of O_2 or 5% CO_2/O_2 reduced the amount of COHb much more quickly. Exercise immediately after exposure markedly increased the speed of elimination. This procedure, however, is not recommended as a treatment. There were no apparent signs that the tests produced deleterious effects to the health and physical well-being of the subjects. No lack of appetite, change of weight or muscular weakness occurred. In general, a distinct increase in hemoglobin occurred. This was accompanied by an increase in red blood cells. No important change occurred in the leucocytes. With the exception of a few occurrences of traces of sugar, no important changes or abnormalities were noted in the urine. Psychological analysis employing tests that were thought would reveal any difference occurring in the performance of the subjects after exposure to CO in the concentrations given failed to show any distinct effect due to the gas, although there was a slight tendency for a poorer performance to be made on a prolonged steadiness test. The difference on all other tests was no greater than the variation on successive control tests.

437. Baader, E.W.: Arsen-Vergiftungen bei der Schädlingsbekämpfung mit Flugzeugen. (Arsenic poisoning during pest control spraying by airplane.) Fühner-Wieland's Samml. Vergiftungsfällen 1:107-8, 1930.

This case report concerns the pilot of an airplane engaged in pest control spraying operations in North Germany. The insecticide he sprayed from his plane at amounts of 3,000-4,000 kg., on warm days even 10,000 kg. daily, was arsenic calcium carbonate. The filling of the tanks before taking off as well as the spraying were accompanied by the formation of dense clouds of the poisonous dust, in the latter case particularly when wind was blowing in his direction. According to the pilot, his mask did not fit properly, but his goggles gave full protection, and he never noticed any eye irritation. The effects of the described exposure were first noted in Sept. 1928 and are summarized as follows: diarrhea usually lasting for 1 day and recurring every 2-3 da., accompanied by severe pains in the calves of his legs, a sensation of dryness of the mouth with salivation, hoarseness, laryngitis, cough and burning pain during swallowing. At the end of Oct., both diarrhea and the pains had subsided, but the salivation, hoarseness and laryngitis persisted. Physical examination revealed redness and swelling of the larynx, i.e., the vocal cords, and redness of the trachea. The condition improved only very gradually. A whitish color developed on the laryngeal mucosa.

The pilot was unable to work for 0.5 yr., when he was re-examined. All symptoms had disappeared except a noticeable roughness of the voice. In May 1929, he resumed his former work and has carried it out ever since without any further complaints.

It is stated that similar effects due to the same exposure have repeatedly been observed. However, due to their reluctance to give up the well paid job, the pilots frequently delay reporting them. Thus, the conditions often are aggravated and it is not possible to examine and administer medications at the first onset in order to prevent or to curb exacerbations.

In the last part of the paper, the author describes an airplane especially designed for spraying insecticides and from the point of view of the least possible hazard. The arsenic acid contents of some German insecticides are given. They range from 40% ("Calciumarseniat") to 5.6% ("Dusturan").

438. Jaensch, P.A.: Zur Klinik und Therapie der Schwefelwasserstofferkrankungen der Augen. (Symptomatology and therapy of eye injuries caused by hydrogen sulfide.) Arch. Gewerbepathol. Gewerbehyg. 1:397-407, 1930.

The injurious effects of H_2S on the organism, recognized in Germany as a compensable disease, include not only severe cases of H_2S poisoning but also, more frequently, eye injuries. Due to the pain and the irritating effects involved, they usually force the affected person to leave the exposure, thus preventing more severe action of H_2S. Experiments involving both humans and animals exposed to the gas, the occurrence of the keratitis, wherever there is an exposure to H_2S, as well as a decrease in incidence as soon as the exposure is mitigated (e.g., by improvement of ventilation) give evidence of the causative role of H_2S. In viscose (artificial silk) manufacturing plants, the workers in the spinning room are those mostly affected, since the exposure is almost exclusively confined to this step of the process. During a period of 3 mo., the author examined 43 workers. On the basis of his findings, the following clinical picture was established: the epithelial layer of the cornea shows stippling, confluent opaque spots, or, in severe cases, vesicles which may burst causing epithelial defects detectable with fluorescein. Further symptoms are blepharospasm, photophobia, appearance of haloes around the lights and secondary conjunctivitis. The degree of pain and the duration

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Jaensch, P.A. (continued)
of the disease depend on the extent of the injury. Both pains and blepharospasm often occur only several hours after leaving the exposure. The fundus oculi is not affected, and the corneal sensitivity is impaired only in the most severe cases; no corneal scars remain. The disease, keratitis superficialis punctata, is due to the direct action of the H_2S in the air rather than to accidental introduction of some H_2S-containing substance into the eyes by hand or to the effects of tiny droplets which might have come into the eyes. In experimental rabbits of various ages, the experimental exposure for several mo. to the atmosphere in the working room did not affect the cornea, even when their resistance was lowered by retrobulbar injections of alcohol. However, fresh H_2S water sprayed or H_2S gas acting directly upon the cornea caused opaqueness within 10 min. and epithelial defects within 30-40 min. Threads prepared in the following manner were placed for 24 hr. on the corneae of anesthetized rabbits, the eyelids being closed by sutures: a) cooked, freed from H_2S and CS_2 and dried, b) treated in the coagulation bath before reaching the bobbin, c) taken from the "cake" (the latter 2 kinds were moist). These results were obtained: a) benign, superficial ulcers, healing within 5-7 da., leaving gray maculae, b) deep ulcers followed by leucomata and c) whiteness of conjunctiva, on 3rd day perforation of the cornea. Under the same conditions, sterilized surgical silk threads did not cause any changes in the eyes of controls, thus ruling out the mechanical action as causative factor. Recommendations are given as to therapy (local) and precautionary measures. MAC is given as 500 ppm.

439. Rostoski, O. and Crecelius, W.: Zur Kenntnis der Sulfitgasvergiftungen. (Contribution to the problem of sulfite gas poisoning.) Deut. Arch. klin. Med. 168:107-22, 1930.

In 1926, when one of the boilers at a German sulfite pulp plant exploded, 33 workers were exposed for 8-45 min. to high concentrations of SO_2 in the air. Of these, 12 died at once or during the next 2 da., 1 died 10 mo. later of purulent bronchitis, bronchiectases and pulmonary emphysema and another of intercurrent croupous pneumonia. Several mo. later, the author examined 10 workers and treated or observed them until 3 yr. after the accident. At that time, he examined 8 workers who had also been affected but had been able to resume their work shortly afterwards in spite of persisting dyspnea, as well as 20 other workers of the plant who had not been in the accident.

No concentrations are given. There was a distinct but nonirritant H_2SO_3 smell throughout the plant. The workers frequently were negligent in wearing their protective masks in working processes involving the inhalation of high concentrations of the gases. The author presents 3 case reports in detail and 7 in summarized form. The exposed workers had suffered cutaneous burns on hands and feet, due to the boiling lye, and 2 of them had fainted. All had conjunctivitis, burning pains in their eyes, laryngitis and cough, severe inflammation of the mucosa of the oral cavity and dyspnea. All symptoms except the cough and dyspnea subsided somewhat during hospitalizations of up to 9 mo. The morning expectorations were tenacious and sometimes bloody. Auscultation revealed rhonchi and an extension of the lower pulmonary borders. X-ray examination showed mottling and localized shadows on the lung and enlargement of the hili. There was neither t.b., pneumoconiosis nor (except in 1 case) a rise of body temperatures. All workers had erythrocytosis. The author states that only 3 of these workers were able to resume their work, 1 of whom is still dyspneic; the other 7 suffer from a persistent, severe dyspnea due to pulmonary emphysema, bronchitis and bronchiectases.

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Rostoski, O. et al. (continued)
The 28 workers examined 3 yr. following the accident (8 who had been exposed but were only slightly affected so that they could return to their jobs within a short time and 20 who had not been involved in the accident) ranged in age from 30 to 65 yr. and had worked in the plant for 2 to 30 yr. All of them had a fresh, healthy appearance and redness of the pharyngeal mucosa. Their condition was typical for erythrocytosis, which the author calls a disease sui generis rather than, as other investigators feel, a symptom of good physical condition, and for chronic pharyngitis. None of these workers had conjunctivitis.

440. Brown, C.E.: Quantitative measurements of the inhalation, retention, and exhalation of dusts and fumes by man: II. Concentrations below 50 mg. per cubic meter. J. Ind. Hyg. 13:285-91, 1931.
422 experiments on the retention of MgO fume and of $CaCO_3$ (marble) dust by 32 human subjects breathing normally while at rest, through the mouth while resting and normally during exercise and during the inhalation of approximately 5% CO_2 in the dusty air were carried out in the manner of the previous series (Drinker, et al., Ibid. 10:13-25, 1928).
The % of MgO retained during normal breathing while at rest varied from ca. 60% at a concentration of 10 mg./m.^{3} to 45% at 50 mg./m.^{3}. The % of $CaCO_3$ retained under the same breathing conditions varied from 80% at 10 mg./m.^{3} to 70% at 50 mg./m.^{3}.
The % retention for mouth breathing while at rest and for normal breathing during exercise and during CO_2 inhalation was ca. 10% less than for normal breathing at rest under the same conditions. (This is illustrated by graph.)
The % retention changed but little at concentrations above 50 mg./m.^{3}, but apparently rapidly approached 100% as the concentration fell below 10 mg./m.^{3}. (Author's summary.)

441. Brown, C.E.: Studies in dust retention: III. Factors involved in the retention of inhaled dusts and fumes by man. J. Ind. Hyg. 13:293-313, 1931.
The effect of the characteristics of respiration and of certain physical properties of MgO and $CaCO_3$ dusts upon the retention of these materials was investigated. Analysis of the data obtained from 418 dust retention experiments (same conditions as in Drinker, et a., Ibid. 10: 13-25, 1928), using MgO in 363 and $CaCO_3$ in 55, and employing 32 subjects breathing normally, showed that % retention varied with certain measurable factors. 1. % retention was inversely proportional to minute volume of air breathed, though this effect probably results from the increase in respiration rate with minute volume. 2. % retention was inversely proportional to respiration rate for rates below 20/min., but above 20/min. there apparently is no change in % retention. 3. % retention was directly proportional to particulate size (not particle size) and to density of dust suspended in air. 4. % retention was directly proportional to the extent to which the dust was wetted in passing through H_2O. The results also showed that % retention apparently was not affected by volume per respiration, vital capacity or relative humidity of inspired air. Published data on dust retention obtained by other investigators are summarized in table form, and a summary of the data on MgO and $CaCO_3$ (to aid in estimating dust retention by man) is graphically presented.

442. Flury, F.: Schwefeldioxyd-Einatmung, Ursache einer perniziösen Anämie? (Is pernicious anemia caused by the inhalation of sulfur dioxide?) Führer-Wieland's Samml. Vergiftungsfällen 2:15-26, 1931.

The possible connection between the inhalation of SO_2 and the subsequent occurrence of pernicious anemia (p.a.) was investigated on the basis of the observations made in one clinical case. The patient had been a 59 yr. old man in good physical condition, who had worked in a mill for the past 33 yr. There was no anamnestic evidence of a predisposition for p.a. In July 1928, he fumigated the mill against meal moths with SO_2, using 5 kg. of S, as he had repeatedly done before. The next day, he suddenly felt severely ill and rested for 3 hr. in a room next to the mill, with the door to the mill open. He continued to work until he had a sudden aggravation of his condition in Jan. 1929. Then he was hospitalized, with the diagnosis of p.a., for 3 mo., discharged without any improvement and died in Oct. 1929. No autopsy was done. The following symptoms were observed: collapse during the examination on the 3rd day after the fumigation of the mill, acute irritation of the pharynx and conjunctivae, severe headache, severe gastrointestinal disturbances, anorexia, insomnia, weight loss (27.5 kg. within 9 mo.), severe blood changes, striking paleness of skin and mucosae. The following blood values are given as results of blood tests carried out 9 mo. after the exposure: Hb - 30, erythrocytes - 1.4 millions.

On the basis of clinical experience and animal experiments, the author discusses further effects, apart from those observed in the described case, that had been attributed to the inhalation of SO_2, e.g., effects on the central nervous system, on the blood or on the hematopoietic organs. Various modifying factors, such as differences in individual resistance as well as adaptation to continued exposure are mentioned. It is pointed out that there are very few reports on fatal SO_2 poisonings in humans, probably due to the highly irritating properties of the gas. There is, however, not one known case, where a clinical picture such as the one described, was attributed to the action of irritant gases, particularly to SO_2. Some information of the nature of p.a. per se as well as following poisoning is presented, and the possible connection between exposure and subsequent death is discussed. In the conclusion, it is said that, as is true for most cases of poisoning, there are several unknown factors, e.g., the exact amount of SO_2 inhaled could not be determined, nor is there positive evidence proving that no p.a. had been present at the time of the exposure. Also, the nature of the disease is not yet fully known. Thus, it is not possible to state definitely whether or not the p.a. in question was entirely due to the inhalation of SO_2. At any rate, it was considered one of the essential causes for the death of the patient.

443. Flury, F. and Zernik, F.: Schädliche Gases: Dämpfe, Nebel, Rauch- und Staubarten. (Noxious Gases: Vapors, Mists, Fumes and Varieties of Dust.) Berlin, J. Springer, 1931, 637 pp.

The contents of this book are discussed in 5 main sections: physical chemistry of the gases, respiratory physiology, toxicology of the gases, therapy of gas poisoning and industrial hygiene aspects. In the section on toxicology, the following gases and fumes are discussed : O_2 and O_3; halogens; S, Se and Te; gases of N, P, As, Sb and C; Si compounds; metal fumes; radioactive substances; petroleum and petroleum products; the following hydrocarbons - paraffins, olefins, acetylenes, cycloparaffins and olefins, aromatics, heterocyclics containing N and S; halogenated aliphatics; monohalogen methyl and ethyl compounds; halogenated aromatics; phenol, fatty alcohols; halogenated fatty alcohols;

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Flury, F. et al. (continued)
ethers; thio-alcohols and ethers; esters; aldehydes; ketones; organic acids; acyl chlorides; cyano compounds; aliphatic nitro, diazo and amino compounds; aromatic nitro and amino compounds; heterocyclic aromatic bases; terpene and camphor.

444. Gaisböck, F.: Zur Wirkungsart von giftigen Gasen und Dämpfen. (The mode of action of toxic gases and vapors.) Wien. klin. Wochschr. 44:937-9, 1931.

Toxic gases and vapors are classified from various points of view. Examples are given in most instances concerning sources of exposure and symptoms produced. The author distinguishes: a) irritating, odorous, absorbed at low concentrations but injurious only at high concentrations, b) nonirritating, odorous, easily absorbed and c) nonirritating, odorless but easily absorbed toxic gases and vapors. For the evaluation of their toxic effect, it is valuable to know their relative "theoretical" toxicity, i.e., concentration and duration of action; absolute toxicity, which is influenced by volatility and evaporation,and the MTC. The minimum lacrimating concentrations of some substances are given. The toxic gases and vapors may be grouped as to 3 main modes of action: a) causing primary injury by local irritation, often at low concentrations, b) injuring, frequently at moderate concentrations, the lower air passages, particularly the lungs, without having a caustic effect on the upper respiratory tract and c) affecting the organism locally, the symptoms appearing after a latent state of up to several weeks. For the evaluation of these local effects, Haber's formula is suggested: C (mg. of substance/l. of air) times t (duration of exposure) = w (effects). The author discusses the symptoms caused by irritating and caustic gases and vapors in the skin, eyes, mucosae of nose and mouth, larynx, lungs, heart and blood. Special emphasis is placed on the action of CO, CO_2 and HCN: numerous concentrations are given, together with their respective effects on the human organism. The effects caused by the exposure to gas mixtures are classified as follows: a) sum of the separate effects of the various components, b) new effects due to the combination and c) sum of all separate effects, modified by the combination. Among the gas mixtures mentioned are: Cl with SO_2 or NO, CO with H_2S or HCN and nitrous gases with CO. The inhalation for 90 min. of the following is fatal: nitrous gases, 740 mg./m.^{3}, CO, 0.4 volume %; mixture of both, 410-425 mg./m.^{3} = 0.16-0.17 volume %. The action of gases separately and as mixtures is summarized as follows from experiments on cats, as reported by W. Wirth in 1930:

NO_2 in mg./m.^{3}	CO in volume %	Death caused in minutes by:		
		NO_2 alone	CO alone	NO_2 + CO
2,500	0.24	33	>90	28
2,800	0.49	37	51	24
2,900	0.48	28	51	17
3,000	0.63	27	29	15

445. Ranelletti, A.: Die berufliche Schwefelkohlenstoffvergiftung in Italien. Klinik und Experimente. (Occupational carbon disulfide poisoning in Italy. Symptomatology and experiments.) Arch. Gewerbepathol. Gewerbehyg. 2:664-75, 1931.

The clinical part of the paper is based on the author's evaluation of all available case reports in Italy (about 100) of occupational CS_2 poisoning. 77% occurred in the rayon industry, the rest in industries where CS_2 was used for the extraction of fats or for rubber vulcanization. In 80% of the cases, the nervous system was affected, while in the other

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Ranelletti, A. (continued)

20%, anemia and gastrointestinal disturbances predominated, often combined with nervous disorders, but without changes in the hematopoietic organs. The following types of nervous conditions, caused by CS_2, are described: 1) CS_2 psychosis (52%) which may occur following a latent period extending over wk., mo. or even yr. with symptoms of excitation and subsequent depression, occasionally, there are acute forms with signs of hysteria and hallucinations, 2) paleostriatal (7%) or pallidal syndromes, 3) neuritis, polyneuritis and paralysis (10%) of both upper and lower extremities, sometimes accompanied by vasomotor or trophic disturbances, 4) impairment of vision such as amblyopia. No concentrations or exposure times causing these effects are mentioned. In Italy as well as in other countries there are very few autopsy reports on cases of CS_2 poisoning. The anatomicopathologic changes mentioned are: adiposity of liver, heart and pituitary body, hyperemia of the cerebral meninges, hemorrhages of the liver and the spleen, as well as neuritis. However, the autopsies did not provide sufficient evidence to establish the cause of death. In most cases of CS_2 poisoning, the prognosis seems to be favorable, and an early removal from the exposure is usually followed by a recovery within a few wk. or mo. Experimentally, 4 rabbits inhaled for 5 mo., 8 hr./day, with an interval of 1.5 hr. between 4-hr. exposures, CS_2 at a concentration of 1 cc./1,000 l. air = 1.28 mg./l. air. The changes produced in the rabbits, very similar to those usually caused in men, may be summarized as follows: hyperemia, hemorrhages and changes in the parenchyma of the organs, pulmonary emphysema and atelectasis, adiposity of the liver, phagocytosis of the blood, increased disintegration of erythrocytes in the spleen. Both the central and the peripheral nervous systems were affected. The cerebral cortex cells showed marked chromatolysis.

446. ✓ Kehoe, R.A., Machle, W.F., Kitzmiller, K. and LeBlanc, T.J.: On the effects of prolonged exposure to sulphur dioxide. J. Ind. Hyg. 14:159-73, 1932.

100 subjects exposed to SO_2 in a refrigerator plant and 100 controls from another part of the plant were selected. Concentrations of SO_2 in the charging room ranged 7-45 ppm in Aug. 1929 and 6-70 ppm in Feb. 1930; in the distribution and storage room they ranged 10-57 ppm in Feb. 1930. Occasionally heavy concentrations escaped into the latter room. Complete historical and present physical data were obtained on each subject. A significantly higher incidence of nasopharyngitis, both chronic and slight, of alteration in sense of taste and of increased sensitivity to other irritants was found in a group of workers exposed to SO_2. These may be thought of as conditions arising from local irritation. A significantly higher incidence of abnormal urinary acidity, of tendency to increased fatigue, of shortness of breath on exertion and of abnormal reflexes was found in the exposed group. These are in the nature of systemic symptoms. There was no demonstrable association between frequency or severity of initial symptoms and frequency of heavy exposure, nor was there any relation between exposure and the frequency and severity of symptoms arising from the customary exposure. A positive relation existed between frequency of heavy exposure and presence of certain symptoms indicative of acid accumulation, viz., increased fatigability during the period of employment and shortness of breath on exertion. The incidence of colds was not significantly different in the 2 groups. The duration, however, was extended in the exposed group. In all other respects as indicated in the text, there was no significant difference between the 2 groups.

447. Kötzing, K.: Schwefeldioxyd-Vergiftung, akute, gewerbliche. (Acute industrial sulfur dioxide poisoning.) Fühner-Wieland's Samml. Vergiftungsfällen 3:239-40, 1932.

In a chemical plant, 2 workers, 26 and 21 yr. old, were engaged in heating a mixture of paraffin and H_2SO_3 in an autoclave and observing the process through a viewing window. Suddenly and for unknown reasons, the window burst and they were struck by the evolving SO_2, especially in the unprotected faces and eyes. The faces and eyes were immediately washed with water and boric acid ointment was applied after which the workers were brought to a hospital. On admission 1.5 hr. after the accident, the examination revealed that both men showed signs of severe cauterization of the conjunctiva, cornea and of the mucosae of mouth and nose. Both had bronchitis extending over both lung fields and accompanied by moist, gurgling, whistling rales. The body temperature and pulse were still normal. Topical therapy, cardiazol and some narcotics against the pains which were especially severe in the eyes were administered. The following day, the body temperatures rose to 39.5°C, the bronchitic rales were much more pronounced and great quantities of yellowish, globular sputum were ejected which contained numerous leucocytes and epithelia. Examination of the blood revealed 12-14% lymphocytes which, however, increased during the following da. The leucocyte count was 8900 and 9700/cc., respectively. Within 10 and 14 da., respectively, the bronchitic symptoms and the effects of the cauterization subsided. The corneal condition, aggravated in one of the workers by a corneal tumor, required treatment for 2-3 more mo. X-ray photographs, taken 4 wk. after the accident, showed increased linear densities and a slight emphysema in one of the patients but distinct emphysema and bronchiectases in the lungs of the other. In both men, corneal opacity due to scar formation remained as permanent injury.

448. Isaev, N.S.: (Poisoning due to nitrogen oxides and sulfur dioxide.) Voenno-Med. Zhur. 4:252-61, 1933.

During the production of H_2SO_4 by the chamber process, both N oxides and SO_2 are given off. In the U.S.S.R., the MAC's are established at: 0.005 mg. N oxides and 0.04 mg. SO_2/l. air. The investigation reported here revealed that in the plants examined, the concentration of these gases varied considerably and often by far surpassed the MAC's: for N oxides by 5-305 times, for SO_2 by 1 1/2 times. The information on the typical clinical picture demonstrated following inhalation of both gases is illustrated by case reports.

The inhalation of both gases produces cough, productive in case of N oxides, more severe and dry in case of SO_2. N oxides may cause pulmonary edema. Following exposure to both, there is fresh blood in the sputum, nausea, vomiting, dyspnea and a feeling of oppression in the chest. Relatively rare are headache and vertigo, while respiration and pulse rates frequently are high: respiration - up to 26/min. in the absence of pulmonary edema, 35/min. with edema; pulse - 78/min. without edema, 120/min. with edema. The latter symptoms are accompanied by an increase in body temperature and changes in the lungs. The body temperatures are subfebrile, when only irritations of the respiratory tract are caused, while action on the lung is demonstrated by a rise in temperature of up to 40°C. within 24-48 hr. after exposure. The reaction of the lung tissue starts immediately upon penetration of the gases into the lungs. Cardiovascular disorders are observed only in cases of advanced edema. No changes in the blood Hb were found.

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Isaev, N.S. (continued)

SO_2 poisoning was studied in 11 patients. The clinical signs included irritation of the upper respiratory tract and degenerative changes in trachea and bronchi, due to surface oxidation of SO_2 to SO_3, subsequent combination with H_2O vapors and absorption by the mucous membranes under formation of H_2SO_4, as well as myocardiac changes.

The action of N oxides (NO, N_2O, N_2O_4) is described as follows: at high concentrations, they have the effects of a mild anesthetic. On the whole, they affect the lungs much more than the upper respiratory tract. In the latter and in the bronchi, inhaled N oxides become HNO_3 which causes reactions in the pulmonary tissue. The salts formed ($NaNO_2$, $NaNO_3$), absorbed by the blood, lower the blood pressure by causing dilatation of the blood vessels. General effects of the nitrites on the organism were seen in only 18% of the cases; much more pronounced was the action of the N oxides on the pulmonary tissue. Poisoning due to N oxides was studied in 27 patients, 16 of whom had pulmonary edema, appearing 8-10 hr. after exposure. The author discusses various phases of pulmonary tissue reaction, complications in cases of pulmonary edema and various aspects of therapy.

Hygienic control measures are recommended.

449. Flury, F.: Resorption gasförmiger Stoffe durch die Haut. (Absorption of gases by the skin.) Festschr. Zangger 2:836-45, 1934.

The absorption of gases by the skin is influenced by various factors, such as: solubility (in lipoids and H_2O), temperature, size and condition of skin area (increased absorption by warm, moist skin), concentration of the gas and the reactive capability of the absorbing organ. Following absorption and temporary storage of the gases in the various cell layers, they enter the blood and lymph systems. The main ports of entrance are the sebaceous glands, less important are the sweat glands. The keratin layer is not completely impervious. The principal protective properties of the skin against the various injuries are discussed. A review of gases as to their absorbability is given. The following gases are absorbed: O_2, Cl_2, Br_2, H_2S which latter may result in percutaneous poisoning, NH_3, CO_2 the absorption of which is harmless, Hg, $Pb(C_2H_5)_4$ in a liquid state, hydrocarbons and their derivatives. C_2H_5OH is probably absorbed, and in solution it penetrates the skin. HCN is is easily absorbed by human and animal skin, and even small amounts are highly toxic. C_6H_5OH is absorbed in the liquid state; $C_6H_5NO_2$ and the related aromatic gases are probably absorbed, but it has not yet been demonstrated. $C_6H_5NH_2$ is absorbed in negligible amounts; following the uptake of nitrochlorobenzene, slight symptoms of poisoning have been demonstrated in cats. N is not absorbed; the absorption of $(C_2H_5)_2O$ and of $CHCl_3$ is doubtful. The absorption of SO_2 has been demonstrated in the broken skin of horses, but not in humans; it is an irritant. The insolubility of CO in H_2O practically prevents the absorption of the gas by the skin. The author reports that a 15-min. exposure of human skin to 2% CO did not result in its absorption by the skin. However, increased and dangerous amounts of the gas might be absorbed when workers are in contact with technical gas mixtures (40% CO) for a prolonged period of time, particularly when doing heavy work in a warm and moist atmosphere.

450. Gerin, C.: Contributo sperimentale alla ricerca chimicotossicologica dell'anidride solforosa. (Experimental contribution to the chemico-toxicological investigation of sulfur dioxide.) Arch. antropol. criminale, psichiat. e méd. légale 54:413-23, 1934.

This paper on in vitro and in vivo studies to determine methods for finding evidence of SO_2 poisoning at necropsy discusses the various methods for testing for SO_2 in vitro and the changes that SO_2 may undergo. SO_2, for example, may form H_2SO_4, or it may combine with H_2S to form free S or H_2O. H_2S is apparently formed as a product of putrefaction after death. Since SO_2 is a gas, it is readily eliminated from the body. It changes to H_2SO_4 in contact with the O_2 of the blood and the moisture of the skin membrane. The problem then was to determine actual SO_2 poisoning and eliminate the possibility of getting positive results due to release of S from protein breakdown or poisoning due to H_2SO_4 or H_2S. Since there is also a danger in confusing H_2S and SO_2, the author removed H_2S with Pb acetate. Alkaline carbonate is added to transform organic compounds of SO_2 into soluble alkaline sulfites. For positive results, immediate post-mortem study is required in chronic poisoning. In acute poisoning the investigation is positive only if made within 48 hr. after the death. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

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451. Kehoe, R.A., Thamann, F. and Cholak, J.: An appraisal of the lead hazards associated with the distribution and use of gasoline containing tetraethyl lead. Part I. J. Ind. Hyg. 16:100-28, 1934.

The dangers encountered in the manufacture of tetraethyl-lead (TEL) and in the blending of the concentrated fluid with gasoline, have led to confusion with the problematical dangers arising from use of the finished fuel (containing a maximum of 3 cc. TEL/gal. gasoline). The difference in the potential lead exposure between the 2 sets of conditions is evident from the failure of Pb-gasoline to produce a substantiated case of Pb intoxication after 8-10 yr. of continuous use in U.S. To investigate whether the magnitude of Pb exposure arising from the combined hazards (skin contact, inhalation) of the use of Pb-gasoline is sufficient to cause appreciable Pb absorption, 3 groups of workmen (56 filling station attendants, 50 tank-truck handlers and 201 garage mechanics) who had experienced all the types of Pb exposure associated with the use of Pb-gasoline for periods of 1-6 yr. were selected for study (in 1929). From every point of view the subjects selected had the maximal opportunity for exposure to Pb arising from their respective occupational contact with Pb-gasoline. In addition, a group of 22 barrel fillers who had severe skin exposure for 6 mo. was compared with a similar group of 27 men previously studied (1927) who had had the same exposure to nonleaded gasoline. Ten of the 22 men were included in both the 1927 and 1929 groups. Half of the filling station attendants and a little less than half of the tank wagon handlers had been exposed for 5 yr. or more, while 69% of the garage mechanics had repaired cars, which used Pb-gasoline, over a period of $\geqq$3 yr. A large proportion of the subjects had been employed in trades which involved some opportunity for Pb absorption, prior to their exposure to Pb-gasoline. Examinations included tests of muscular strength, blood pressure, analysis of urine and feces and hemoglobin determinations. Blood smears were made on all subjects and examined for stippling of erythrocytes. Erythrocyte, leucocyte and differential leucocyte counts were made as a routine procedure only on the barrel fillers; otherwise, only when indicated for diagnostic purposes. No case of Pb poisoning was found among the subjects. In

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Kehoe, R.A. et al. (continued)
fact, no combination of symptoms and physical findings was suggestive of Pb intoxication. Of special negative clinical importance were the complete absence of Pb line, the lack of significant microscopic blood changes (stippling) and the infrequency of vague symptoms of ill health. Results of analyses of urine and feces serve to classify the various groups of subjects as distinctly outside the hazardous Pb trades. A special significance is attached to the failure of the barrel fillers to show any increase in the Pb excretion as a consequence of their exposure to Pb-gasoline. None of the 10 persons examined prior to and after 6 mo. exposure to Pb-gasoline showed an increased rate of Pb excretion. Results of a 1927 survey of 71 medical students, 114 filling station attendants and 35 garage mechanics with no exposure to Pb-gasoline are presented. Comparison of mean values reveals no statistically significant difference between the groups. Moreover, there was no measurable change in the Pb excretion of 26 filling station attendants and 24 tank wagon handlers who served as subjects in both the 1927 and 1929 studies. The findings of this investigation are shown clearly in the following table:

Description of subjects	Age	Systolic blood pressure (Sitting)	Pb in mg./g. ash in feces	Pb in mg./l. of urine	Hemoglobin readings
Medical students not exposed to Pb-gasoline, examined in 1927	22.3 ±0.2	125.9 ±0.8	0.079 ±0.008	0.078 ±0.007	89.8 ±0.6
Filling station and tank wagon handlers not exposed to Pb-gasoline, examined in 1927	37.5 ±0.8	138.2 ±1.5	0.077 ±0.006	0.081 ±0.006	86.0 ±0.5
Filling station attendants exposed to Pb-gasoline, examined in 1929	40.8 ±1.2	130.1 ±1.7	0.087 ±0.007	0.071 ±0.005	80.9 ±0.67
Tank wagon handlers exposed to Pb-gasoline, examined in 1929	38.6 ±1.1	130.4 ±1.9	0.120 ±0.014	0.089 ±0.011	85.0 ±0.59
Garage mechanics not exposed to Pb-gasoline, examined in 1927	31.12 ±0.8	129.8 ±1.3	0.131 ±0.023	0.077 ±0.008	88.0 ±0.7
Garage mechanics exposed to Pb-gasoline, examined in 1929	34.3 ±0.5	125.7 ±0.7	0.131 ±0.005	0.086 ±0.004	84.5 ±0.24
Barrel fillers not exposed to Pb-gasoline	37.9 ±1.2	134.3 ±1.8	0.137 ±0.014	0.058 ±0.009	71.1 ±0.92
Barrel fillers exposed to Pb-gasoline	39.1 ±1.3	129.1 ±2.3	0.113 ±0.007	0.052 ±0.004	83.3 ±0.91

In view of this negative evidence, there is no reason to fear the existence of danger to the public health from the distribution and use of Pb-gasoline.

452. Nikulina, M.M., Hetmann, Z. and Margolina, N.M.: (Morphologic and biochemical changes in the blood in acute sulfur dioxide poisoning.) Leningrad Inst. Invest. Diseases 8:89-93, 1934.

The morphology of the blood is not changed in SO_2 poisoning, but there is an increase of acid and of sugar in the blood, and this acidosis may be the chief cause of death. Administration of soda lessens the severity of the symptoms in animals and prolongs life. (Abst. Heimann, H. et al., U.S. Public Service, 1950.)

453. Lehmann, G.: The dust filtering efficiency of the human nose and its significance in the causation of silicosis. J. Ind. Hyg. 17:37-40, 1935.

The apparatus used to measure the dust filtering efficiency of the human nose is diagramed. Dusty air was blown into the nose, while the breath was held, and allowed to escape through the mouth. The concentration of the air was determined before and after. Rock dust (high silica content) with an average particle size of 0.5-2 µ was used. Healthy men of various ages were exposed and their nasal filtering capacity found to vary from 10-70%. The amount of nasal secretion did not greatly affect retention, nor did differences in the chemical composition of the dust. 426 miners (241 silicotic and 185 healthy) were also exposed. Of the healthy subjects 63% had retention efficiencies >40, 19% between 30-40 and 18% <30; of the silicotics only 21% had nasal retention efficiencies >40, 17% between 30-40, and 62% <30.

454. Dreyfus, J.R.: Lungencarcinom bei Geschwistern nach Inhalation von eisenhaltigem Staub in der Jugend. (Pulmonary carcinoma in sister and brother due to the inhalation of dust containing iron oxide.) Z. klin. Med. 130:256-60, 1936.

The first case report concerns a 44-yr. old woman. Her anamnesis is described as normal except that, following complaints about palpitation and accelerated respiration, she had undergone strumectomy 3 mo. before the reported admission to the hospital. Subsequent to this operation, pains in the left pleural region and dullness, distinctly noticeable on auscultation, appeared. 1.33 l. of reddish pleural exudate were aspirated 5 wk. before admission and 1 l. of yellow-brown exudate 3 wk. before this day. The admission X-ray revealed an intensive shadow in the left lower and middle lung lobes. Physical examination showed considerable diminishing of respiration on the left thorax side, and a lymph gland was detected in the left supraclavicular region. Within 2 da., 500 and 870 cc., respectively, of pleural exudate were punctured which did not contain tumorous cells but abundant amounts of protein and lymphocytes. Biopsy of the supraclavicular lymph gland revealed that it was a metastasis of a carcinoma solidum the primary tumor of which was assumed to originate in the lungs. The patient died 3 wk. later under the signs of pulmonary cancer; no autopsy was performed. 9 mo. later, the 36 yr. old brother of the woman was admitted to the hospital. During the previous year, he had suffered attacks of bronchitis, pleuritis exudativa and general dyspnea. Examination on admission disclosed the presence of a tumor of 5 cm. diameter, in the right supraclavicular region which grew rapidly, and also 2 lymph glands in the same region. Results of pleural exudate analysis are given and also those of blood tests which generally showed too high values. After temporary improvement due to therapy with X-ray irradiation, death from pulmonary carcinoma occurred 5 mo. after the patient's first admission to the hospital. Etiologically, the following information is given: during the period extending from the brother's birth (age of sister 8 yr.) and his 12th yr., both sister and brother had continuously been exposed to the inhalation of Fe_2O_3 dust at home where the mother worked part time polishing watches with a powder containing this dust. Thus, there was a period of 24 yr. between the end of the exposure and the outbreak of the disease, i.e., an exogenous factor, in this case the inhaled Fe_2O_3 dust, had produced pulmonary cancer which appeared after so prolonged a latent state. Another case report concerns a woman, 33-yr. old, whose death, within 3 wk. after admission to the hospital, of carcinoma solidum et cylindrocellulare of the lung was attributed to a similar exposure as was the one described above. It is stated that women are not less susceptible to the development of pulmonary

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Dreyfus, J.R. (continued)
carcinoma than men. Various factors have been mentioned in publications on the subject as predisposing or causing pulmonary cancer, of which the author discusses those endogenous in nature (grippe and malnutrition) and exogenous, such as quarry, lignite, coal, nicotine, industrial smokes and dusts and those in the city streets.

455. Holste, A.: Beobachtungen bei Vergiftung durch nitrose Gase am Menschen. (Observations on poisonings from nitrogen gases in man.) Zentr. Gewerbehyg. Unfallverhüt. 23 (N.F. 13):183-6, 1936.
In a chemical plant, one of the connections of a water hose, used to extinguish a fire, hit a container filled with HNO_3. It broke, spilling the acid over the floor. Without wearing masks, 3 firemen went to fight the acid and the developing N gases with water. The poisonings caused by the inhalation of these gases in the 3 and also the other firemen varied in severity, depending on the degree of exposure: one of them died after 24 hr. of acute pulmonary edema and severe signs of circulatory disturbances, after first having demonstrated a state of apparent well-being; 10 were severely affected, the others suffered only moderate nausea and irritation of the upper respiratory tract, which subsided rapidly. The clinical data on the 10 severe cases are tabulated and may be summarized as follows: The patients ranged in age from 22 to 58 yr. They complained about cough, both dry and accompanied by expectoration, shooting and burning pains in the thorax and headache. Further subjective signs were: hyperhydrosis, dyspnea, congestion in the head, palpitation and the sensation of pressure in the heart, vertigo, nausea, accompanied by vomiting, nervousness, insomnia and cold hands. On examination, the following signs were found: viscous expectoration, gray-yellow to brown-red and sanguinolent in color, tachycardia, facial hyperemia and cyanosis, acrocyanosis of the hands, as well as dermographism. 2 patients had proteinuria, one showed increased reflexes. The X-ray examinations gave negative results. The blood tests showed Hb values of over 100% and high erythrocyte values in 6 cases, 1 had a Hb content of 100% and 3 had normal Hb values. Most of the patients were followed for periods up to 20 mo. The blood tests revealed in all cases a more or less marked increase in Hb content at varying times during this whole period. This increase in Hb and also erythrocyte values is explained by an irritating action on the bone marrow. No clinical changes were detected in the inner organs, except on X-ray, some cloudiness on the right hilus and also some hemoptysis in 1 patient, and on auscultation, some rales in the subclavicular region in another, while in a 3rd, acrocyanosis, dermographism and bloody expectoration persisted for ca. 18 mo. Therapy was confined to symptomatic treatment and rest.

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456. Kehoe, R.A., Thamann, F. and Cholak, J.: An appraisal of the lead hazards associated with the distribution and use of gasoline containing tetraethyl lead. II. The occupational lead exposure of filling station attendants and garage mechanics. J. Ind. Hyg. Toxicol. 18:42-68, 1936.
Under controlled experimental conditions as to normal Pb intake and output, the Pb metabolism of 2 healthy young men did not change measurably in 4 mo. of employment (53 hr./wk.) as filling station attendants dispensing large quantities of Pb-gasoline. No indication of occupational Pb absorption was given by the subjects. Two filling station attendants who had handled large quantities of Pb-gasoline over periods of 3.5 and 6 yr., respectively, when abruptly removed from employment and studied under laboratory conditions for 4 mo., failed to show any initial or subsequent abnormality in fecal or urinary Pb excretion, or other evidence of occupational Pb absorption. Two healthy young men studied in the laboratory for

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Kehoe, R.A. et al. (continued)

4 mo. before engaging in the repair of automobiles operated on gasoline containing 3 cc. tetraethyl lead (TEL)/gallon, and similarly followed for 5 mo. of such employment, developed no demonstrable change in Pb metabolism or other evidence of occupational Pb absorption. In the course of this study, analyses were made of the Pb content of floor sweepings. These were: within the entrance drive, 9.35 mg./ft.^{2} (36 g. sample); repair areas, 1st floor, 817 mg./ft.^{2} (45 g. sample); 2nd floor, 6.77 mg./ft.^{2} (45 g. sample); Pb in air of garage (repair areas 1st and 2nd floors) 0.03-0.06 mg./m.^{3}; at elevator 2nd floor, 0.14 mg./m.^{3}. A garage mechanic occupied for 8 yr. in the repair of cars using only gasoline containing the maximum concentration of TEL, when taken from employment for a 61-day study, maintained a slightly elevated urinary Pb excretion, as compared with the other subjects of this study and with normal individuals similarly studied. Another mechanic employed for 10 yr. did not give conclusive evidence of increase in urinary Pb excretion. In neither case was there any measurable increase in fecal Pb excretion. The Pb contents of food, feces and urine of the above subjects were as follows:

	Before Exposure				After Exposure			
	Food	Feces	Urine		Food	Feces	Urine	
Subjects	mg./ 24 hr.	mg./ 24 hr.	mg./ 24 hr.	mg./ l.	mg./ 24 hr.	mg./ 24 hr.	mg./ 24 hr.	mg./ l.
Filling station	0.177	0.233	0.025*	0.022	0.222	0.314	0.028*	0.029
attendant	±0.013	±0.013		±0.001	±0.013	±0.017		±0.002
Filling station	0.189	0.220	0.032*	0.026	0.157	0.185	0.026*	0.022
attendant	±0.012	±0.12		±0.001	±0.010	±0.011		0.001
Filling station)5-						0.173	0.014*	0.015
attendant)6						±0.010		±0.001
Filling station)yr.						0.190	0.020*	0.020
attendant)serv.						±0.008		±0.002
Garage mechanic	0.196	0.178	0.020*	0.024	0.166	0.178	0.015*	0.012
	±0.022	±0.010		±0.002	±0.008	±0.007		±0.001
Garage mechanic	0.203	0.162	0.014*	0.018	0.185	0.218	0.012*	0.013
	±0.033	±0.010		±0.003	±0.018	±0.011		±0.001
Garage)8-					0.141	0.213	0.029*+	0.026
mechanic)10					±0.008	±0.021		±0.003
Garage)yr.					0.183	0.265	0.048*	0.045
mechanic)serv.					±0.012	±0.021		±0.002

*Calculated from the mean values for 48-hr. and 72-hr. samples
+Mean unstable. Low frequency and high variability.

This evidence, in conjunction with the results of random observations on many persons similarly employed, justifies the following conclusions. The Pb exposure associated with the handling and dispensing of gasoline containing TEL at service stations of the prevailing type in the U.S.is negligible. The Pb exposure arising from prolonged employment in the care and repair of automobiles using Pb-gasoline for fuel, may be sufficient to cause slight increase in the mean rate of urinary Pb excretion, shown either in a greater Pb output per unit time or in higher Pb concentration. No increase in the fecal Pb excretion has been demonstrated. Because of the number and variety of opportunities for slight exposure to Pb in the garage mechanic's occupation, the proportion of total Pb exposure deriving from Pb-gasoline and its combustion products is conjectural. In view of the difficulty of detecting the occupational Pb exposure of garage mechanics, as compared to the ease with which Pb exposure may be demonstrated in hazardous Pb trades, there is no reason to believe that the usual type of automobile service and repair work involves danger from Pb absorption.

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Kehoe, R.A. et al. (continued)
However, significant Pb hazards may exist in garages in which storage batteries are repaired, or in which molten Pb, Pb pigments and Pb paints are handled regularly. (From authors' summary and conclusions.)

457. Dowling, H.F.: Asthma following prolonged exposure to sulfur dioxide: Report of case. Med. Ann. District of Columbia 6:299-300, 1937.

A 25-yr. old white man worked as a refrigerator repairman in an 8' X 10' room unventilated except for 1/2 hr./day. Though he was quite well before starting this job, he noticed a slight cough during work which was particularly marked when refrigerators were taken apart and a large amount of SO_2 allowed to escape. After ca. 4 da. of work, the cough became productive of sputum, which gradually became more abundant. Dyspnea on exertion and generalized weakness developed. 42 da. after starting the job, he had to leave work early and was unable to return. He could not lie down to sleep at night. A fellow repairman, working under the same conditions, developed a slight cough while at work only. The patient gave a history of slight asthma on a few occasions when he was 8, which stopped without treatment, and the family history showed that his mother had had asthma. Physical examination revealed only a moderate number of sibilant and mucous rales through both sides of the chest. Analyses of the urine and sputum showed a high % of eosinophiles. He improved upon treatment with subcutaneous injections of increasing doses of 1:10 dilution of house dust extract to which he had shown sensitivity; also, all possible sources of dust were removed from his environment. From this it is shown that the patient had several indications of an allergic constitution due to which he developed symptoms of asthma after repeated and prolonged inhalation of SO_2. However, according to the best evidence available, the inhalation of SO_2 over a long period of time causes no permanent damage to experimental animals or normal human beings.

458. Holland, G.: Zur Klinik der Nitrosegasvergiftung. (The clinical aspects of poisoning due to nitrous gases.) Med. Klin. 33:930-2, 1937.

The 4 principal types of poisoning due to inhalation of nitrous gases, as established by Flury, are described: 1) poisoning due to irritant gases, 2) reversible type, 3) shock type, 4) type with initial signs of 2) but subsequent course similar to 1). The extent and the kind of pathologico-anatomic changes depend on both the amount, concentration and composition of the inhaled gases and the duration of exposure. For cases terminating rapidly in death, the following clinical picture is typical: pulmonary edema and hyperemia, alveoli filled with air and exudate; frequently, ruptures of the alveolar or bronchiolar walls with acute emphysema, or localized pneumonia; occasionally, fibrinous pleurisy. In fatal cases where there is a prolonged period of time between the exposure and death, e.g., 3 wk., the described condition leads to bronchiolitis obliterans, accompanied by cardiac dilatation, hemorrhages and degeneration. The reversible type of poisoning due to nitrous gases (nonfatal) is demonstrated by the clinical picture described in the case report concerning a 30-yr. old fireman who was admitted to the hospital 4 hr. after the exposure to inhalation of nitrous gases. No concentrations are given. The subjective signs included: soreness and dryness of the throat, a feeling of constriction in the chest and dyspnea. Examination on admission revealed moderate cyanosis, hyperhydrosis of the face and extremities, rales. The body temperature was 36.7°C., pulse 75/min., respirations 35/min., and the blood pressure was 130/70. Examination of urine and sputum gave negative results. On the following day, the patient's respiration was even more accelerated, the body temperature was 38.5°C., and

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Holland, G. (continued)
40 cc. of foamy, nonfibrinous sputum were expectorated. Under therapy, all of the described symptoms subsided within 6 da. A comparison of the X-ray picture taken 15 hr. after the exposure with those taken 2 da. later and at regular intervals during the next few mo. demonstrated that the numerous opaque foci (probably sterile pneumonic exudates in the alveoli and bronchioles), reminiscent of miliary t.b., had almost disappeared after 2 da. However, the increase in the number of erythrocytes (5.5-6.2 million/cc. blood) and in Hb content (96-118%) continued for the next 8 mo. Both bleeding time and coagulation time were normal.

The changes in the blood picture described in this case are supported by tabulated data from clinical records of other firemen following the exposure to the inhalation of nitrous gases.

459. Rawlins, A.G.: Use of sulphur dioxide in the treatment of the epidemic cold. Arch. Otolaryngol. 25:119-23, 1937.

The study is limited to epidemic colds which pass through families and neighborhoods, as does measles, in contrast to flare-ups of sinusitis or streptococcus sore throat. The use of SO_2 was prompted by success in destroying plant viruses with 0.6-1.5% of SO_2. SO_2 was administered by inhalation of H_2SO_3 gas. Of 80 patients, 14 received no relief, and 66 stated they were completely cured on the 1st or 2nd day after therapy was started. These 66 patients stated that their colds usually lasted 1-2 wk. Treatment in each case was given in the prodromal stage of the cold. The same therapy was tried after 3 or 4 da. of onset with practically negative results. "It was found that in what was apparently an epidemic of colds, SO_2 gas inhaled in the 1st 12 hr. stopped the cold in 24 hr. in a large % of the cases." The technic required getting the SO_2 gas into the upper respiratory tract without getting appreciable amounts into the lungs. The possibility of decreased colds among workers exposed to SO_2 is discussed. The author questioned a few workers and 1 plant manager in a plant where there was exposure to SO_2 and found that colds were infrequent. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

460. Roholm, K.: Fluorine Intoxication; A Clinical-Hygienic Study with a Review of the Literature and Some Experimental Investigations. London, H.K. Lewis and Co., 1937, 364 pp.

This most complete review of the literature on the physiology and toxicology of F and its compounds to 1936 (893 references) is followed by a detailed description of the author's investigations into "spontaneous cryolite poisoning" in workers processing cryolite ore, and of his experimental observations on animals (rats, pigs, calves, dogs) fed various amounts of fluoride salts.

461. Tourangeau, F.J. and Drinker, P.: The dust filtering efficiency of the human nose. J. Ind. Hyg. Toxicol. 19:53-7, 1937.

The nasal resistance to unidirectional airflows of 4, 8 and 12 l./min. was determined upon normal subjects. Then the nasal filtering efficiency was determined at the same rates of airflow using limestone dust (325 mesh) that had been dispersed and allowed to settle 20 min. Readings of the air, made by a tyndallmeter, were taken before and after the subject had inserted the nasal catheters (exhalation) or the mouth tube (inhalation). Practically no efficiencies >30% were found. The authors conclude that the filtering efficiency of the nose is very poor compared to commercial dust filters.

✓ 462. Vigdortschik, N.A., Andreeva, E.C., Matusswitch, I.L., Nikulina, M.M., Frumina, L.M. and Striter, V.A.: Symptomatology of chronic poisoning with oxides of nitrogen. J. Ind. Hyg. Toxicol. 19:469-73, 1937.

In an attempt to reveal the symptomatology of chronic N oxide poisoning, 127 men who had worked 3-5 yr. in H_2SO_4 plants and as etchers in printing shops and were thus daily exposed to low concentrations (up to 0.005 mg./l.) of N oxides were studied; the clinicostatistical method was used. In the majority of cases NO_2 was the only injurious gas detectable. The data collected on these men were compared with similar data on control groups, i.e., groups of workers of the same age composition living under similar conditions but who were not exposed to toxic substances in the course of their daily work. The observed symptoms statistically proved authentic were: wearing down of teeth, inflamed mucosa of the gums, emphysema of the lung, t.b. of the lungs (compensated), hypotonia, bradycardia, high hemoglobin content, large numbers of erythrocytes, increased vital granulation, marked basophile granulation, increase in the maximum resistance of erythrocytes, accelerated agglutination of blood, reduced catalase index, reduced reserve alkalinity, decreased sugar content and lability of the sugar curve. The symptoms statistically shown to be probable were: carious decay of teeth, disturbed gastric secretion, chronic bronchitis, cardiovascular neurosis, moderate leucopenia with a decreased number of rod-like forms, moderate lymphocytosis, increase in the minimum resistance of erythrocytes, delayed reaction to the precipitation of erythrocytes and increased content of bilirubin. Most of these symptoms are attributed to the resorptive action of N oxides; some of the symptoms clearly owe their origin to hemolysis, others to the disturbed functions of the vegetative nervous system. Further, 5 working men who had given up this type of occupation 3-16 mo. previously and were engaged in nontoxic work then, were carefully examined. The results in all 5 cases showed a definite tendency of the blood to return to normal composition, thus indicating that giving up work with N oxides results in the gradual elimination of the differences between the exposed and the control groups.

463. Oettel, H.: Explosionsgas-Vergiftungen an der freien Luft. (Poisoning due to explosive gases in the open air.) Fühner-Wieland's Samml. Vergiftungsfällen 9:1-2, 1938.

During the war in China, analyses carried out at the Institute of Pharmacology of the University of Tung Chi have demonstrated that certain fatalities were due to the inhalation of explosive gases, although the incidents had occurred in the open. 5 soldiers had been in a trench, 3m. long and 1 m. high which was covered with twigs and leaves when an exploding shell lowered this "roof." All soldiers lost consciousness although none was injured. 2 soldiers recovered completely after having left the trench within a short time. The 3 others, covered with earth up to their chests, remained in the trench for several hr. and were still unconscious and dyspneic when they were taken out. 2 of them died a few hr. later without regaining their consciousness. In a similar incident, another soldier noticed a pungent, burning, irritating odor before losing consciousness for 2 hr. "Soon" after the explosion, he was removed from the trench and received O_2 treatment, after which the initial hemoptysis and dyspnea had subsided. Within 2 da., all symptoms had disappeared. With regard to the 2 fatalities mentioned above, the following autopsy findings are given: distinct garlic odor of the organs, moderate pulmonary edema and tracheitis. No definite cause of death could be established on the basis of autopsy results. The blood showed the following COHb contents: 75% in one case and 65%

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Oettel, H. (continued)
in the other, although the affected men had breathed fresh air for 12 hr. after the explosion. These high COHb concentrations were probably due to a reduction in respiration caused by a) covering of large portions of the men's bodies with earth and b) the effects of the NO_2 content of the explosive gases. Evidence of the latter were the conjunctivitis, tracheitis and the pulmonary edema which decreased the O_2 uptake and the CO loss. Death was caused by the combined action of the 2 gases: the acute CO poisoning (usually not fatal when occurring in the open because of sufficient O_2 supply) and the NO_2 poisoning, preventing the O_2 supply.

The described incidents demonstrated the importance of immediate supply of O_2 in case of poisoning due to the inhalation of explosive gases which is considered even more necessary here than in poisoning due to CO alone.

464. Barthelemy, N.L.: Ten years' experience with industrial hygiene in connection with the manufacture of viscose rayon. J. Ind. Hyg. Toxicol. 21:141-51, 1939.

The potential health hazards in viscose rayon manufacture result from possible exposure to caustic soda, H_2SO_4, CS_2, H_2S and $(NH_4)2S$. Handling of the first 2 offers substantially the same problem as in all chemical plants, the risk being from accidents rather than from chronic exposure. CS_2 vapor, which is very inflammable, is found in the churn and spinning rooms of viscose plants, while H_2S is generated in the spinning process alone. Both gases are occluded in the spun rayon (or cakes) and may, therefore, be detected in the washing processes which follow spinning. In 10 yrs.' operation of the Tubize Chatillon plant at Rome, Georgia, CS_2 and H_2S determinations have been made regularly at all points where workmen might breathe these vapors. During this time only 3 cases of acute CS_2 intoxication were registered; the symptoms observed included mental depression and queer action in 1 case and a definite disturbance of the motor nerves, especially in the legs, in the other 2 cases. All 3 recovered completely in several mo. Excessive exposure to H_2S occurred in 1933 in which a number of workers were affected with the following symptoms: intense photophobia, spasm of the lids, excessive tearing, intense congestion, pain, blurred vision, the pupils were contracted and reacted sluggishly, the cornea was hazy and sometimes numerous blisters could be seen. It is now believed that the simultaneous presence of CS_2 and atomized particles of spinning bath promote a hypersensitiveness of the conjunctiva and cornea to H_2S. Concentrations gradually have been reduced to the point where eye irritation from H_2S or systemic effects from CS_2 have been eliminated. It was found that if CS_2 was kept below 0.1 mg./l. (or <30 ppm by volume) and H_2S below 0.03 (or <20 ppm by volume), no trouble whatever was experienced. The $(NH_4)_2S$ hazard was very slight, having caused only 3 cases of conjunctivitis.

465. Romanoff, A.J.: Sulfur dioxide poisoning as a cause of asthma. J. Allergy 10:166-9, 1939.

Cook believed, on clinical grounds, that there may be a certain specificity in the inhalation of SO_2 fumes, principally because this gas initiates attacks in relatively few asthmatic individuals, and in those who were free from asthma attacks for some time. However, there is no immunological proof of the specificity of SO_2 fumes in initiating attacks of bronchial asthma. Those exposed to SO_2 fumes have an inflammatory destructive lesion in the upper respiratory tract. The mucous membranes are rendered helpless, and the bacteria gain the upper hand. Inhalation of SO_2 is very irritating to the upper respiratory tract. SO_2 plus moisture

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Romanoff, A.J. (continued)
of membranes forms H_2SO_3, which is very irritating and in severe cases can produce bronchopneumonia and pulmonary edema. A group of 100 people with chronic exposure to SO_2 had a diminution of taste and smell, and an increase in incidence of pharyngitis and tonsillitis, and an increase in fatigability and dyspnea on exertion. Three cases of asthma in refrigerator-repair men are cited in which SO_2 is said to be the cause of the asthma. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

466. Symanski, H.: Gewerbliche Vanadinschädigungen, ihre Entstehung und Symptomatologie. (Industrial vanadium poisoning, its origin and symptomatology.) Arch. Gewerbepathol. Gewerbehyg. 9:295-313, 1939.

In 1934, in Germany, the amount of V used amounted to 150,000 kg., and in 1937, 400,000 kg. were used. The author discusses the production, the properties of the metal and its uses and reviews publications on its effects on the organism, stressing the divergence of opinions and experiences on the subject. As a result of complaints from workers in a V-producing factory, he had carried out physical examinations, including blood and urine tests and X-rays, of all workers and employees of the plant. The hazard in this plant was the inhalation of V_2O_5 in the form of very fine dust. No concentrations or other results of air analyses are given. From the 19 case reports presented, a characteristic clinical picture is demonstrated: the typical symptoms are conjunctivitis, rhinitis, pharyngitis, severe cough with expectoration, the sensation of constriction of the chest, subacute or chronic bronchitis, rales, abundant secretion from nose and eyes. No injuries were detected in the digestive and urinary tracts, the central nervous system, eyes and blood. None of the workers or employees had been exposed to the V_2O_5 more than a "few years"; it is believed, however, that prolonged further exposure might cause an aggravation of the described conditions and that then, bronchiectases or specific infections might develop. On the other hand, improvement or complete disappearance of the symptoms was observed in young persons after they had spent a few days or weeks in an exposure-free atmosphere, e.g., on vacation.

467. Witheridge, W.N. and Yaglou, C.P.: Ozone in ventilation--its possibilities and limitations. Heating, Piping Air Conditioning 11:648-53, 1939.

The physical, physiological and pharmacological properties of O_3 are reviewed. The irritation threshold appears to be ca. 0.05 ppm. The destructive action of O_3 is mainly localized on the mucous membranes of the respiratory tract. O_3 in concentrations of 0.015 ppm could barely be smelled by occupants of a room and reduced body odor detection sufficiently to permit a reduction of at least 50% of the amount of outdoor air necessary for odor control. Higher concentrations were irritating to the mucous membranes of the upper respiratory tract, while lower concentrations had no effect on body odors. The action of O_3 on body odors appears to take place not in the air of the room by oxidation but on the mucous membranes of the nasal passages by masking. Although O_3 in sufficient strength completely prevented body odor detection, it was difficult to counteract the 2 odors so that neither could be detected by persons entering the room from outdoor air. O_3 had to be present in perceptible concentration to do any good at all.

468. Evans, E.E.: An X-ray study of industrial gases on the human lung. Radiology 34:411-24, 1940.

Serial X-rays of the chests of a large number of men exposed to 4 different type chemicals were taken over a period of 5 yr. All operational procedures were modern, but occasionally leaks and other exposures to low concentrations occurred. The first group of 35 men (average age - 38 yr.) was exposed to Cl_2 and HCl in the manufacture of these products. The average service in the industry was 9.5 yr.; that in the Cl_2 area, 6.4 yr. Comparison of the chest X-rays showed no increased pulmonary fibrosis over the 5 yr. The second group of 18 men (average age - 44 yr.) was exposed to SO_2 and SO_3 in the manufacture of H_2SO_4. The average service in the industry was 13.5 yr. and in the area, 10.7 yr. Comparison of X-ray films showed not only no increase in pulmonary fibrosis, but, in some cases, less fibrosis. The 3rd group consisted of 74 men (31.7 yr. average age) who were exposed to H_2F_2 acid fumes and its combination products. The average service in the industry was 4.9 yr., and in the area, 2.7 yr. There have been many operating difficulties in this area and the fumes have been severe at times. More recently operational procedures have been improved. But the X-ray films showed no pulmonary fibrotic increase. The 4th group of 41 men (average age - 39.7 yr.) was exposed to $COCl_2$, $POCl_3$ and PCl_3. Average service in the industry was 10.5 yr.; in the area, 8.4 yr. Again there was no increase in pulmonary fibrosis, and, in some cases, less fibrosis. The workers who have not been ill have also been observed through an insurance plan and it was found that there is no higher death rate from pneumonia and other pulmonary infections in this group than that recorded for the other plant employees.

469. Ter Heege, F.H.: Over mechanische prikkeling van het neusslijmvlies door in de lucht zwevende partikels. (Rhinitis due to mechanical irritation of the nasal mucosa by floating particles.) Geneesk. Tijdschr. Ned. Indië 80:2512-6, 1940.

Some examples are given of mechanical irritation of the nasal mucosa. Apparently, there is a resemblance between the symptoms caused by mechanical irritation and those due to hay fever and vasomotor rhinitis, i.e., nonseasonal rhinitis. In rhinitis due to mechanical irritation, no positive cutireaction can be produced, whereas it frequently occurs in allergic rhinitis. On the basis of literature on the subject and the author's own observations, the symptomatology of mechanical irritation of the mucosae of nose and eyes is described. In cases of allergy, the body reacts by means of defense mechanism, e.g., reagin, but not so in case of mechanical irritations. In most cases of allergy, there is a positive cutireaction within 20 min. In both cases, the reaction of the organism is produced by the introduction of an irritating substance into the nose. In the following case reports, the author describes his own observations. A 51-yr. old patient was engaged on his job in planing teak wood, during which much dust developed. For the past 1/2 yr., he had complained about having abundant, light-colored, slimy and watery nasal secretion. On examination, purulent mucus was found in the nose; pharynx and nasopharynx were normal. There was X-ray evidence of bilateral shadows in the sinus frontalis and maxillaris. According to the patient, several other workers having the same exposure complained about similar conditions. The recommended treatment is discussed, which, however, prevented the symptoms only as long as it was used. Another patient seen was a 31-yr. old man who had suffered from pharyngitis for the last few yr. 2 yr. prior to the examination, he had undergone tonsillectomy. The patient complained about throat irritation, a feeling of oppression in the chest, insomnia and "abnormal" sensation in the clavicular region and above the sternum. On conservative therapy, the

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Ter Heege, F.H. (continued)
pharyngitis subsided and the other symptoms regressed. Some days later, the patient was exposed to the inhalation of insecticides on the job, whereupon he experienced an acute recurrence of the symptoms described above. An intracutaneous injection of the insecticide gave a negative cutireaction. According to the patient, the same exposure had caused irritation of the nasal mucosa as well as of that of pharynx and eyes also in other fellow workers. The third case report concerns a patient who was exposed to the inhalation of fine particles of sand in the air. The typical symptoms, including sneezing, abnormal injection of the nasal mucosa and signs of irritation regressed on local therapy within 4-5 da. The mechanical action of the sharp-edged sand particles was established as the cause of the irritations seen in this patient. Other typical symptoms are: abundant, mucous nasal secretion, pharyngeal irritation, often progressing to painful, chronic pharyngitis and conjunctivitis. Recommendations are given for the prevention of mechanical irritation of the mucosae.

470. van Wijk, A.M. and Patterson, H.S.: The percentage of particles of different sizes removed from dust-laden air by breathing. J. Ind. Hyg. Toxicol. 22:31-5, 1940.

The proportion of siliceous dust (quartzite) particles of size ranges <0.2, 0.2, 0.4, 0.8, 1.2, 1.6, 2.0, 2.5, 3.0, 4.0 and 5.0 μ removed from dust-laden air by breathing was measured in an apparatus using 2 thermal precipitators (1 collecting samples of the dusty air at the level of inhalation; the other, samples of exhaled air). 40 experiments were run on 3 human subjects with a normal average breathing rate of 17 l./min. (lpm) and a number of breaths of 19/min. 20-min. samples were collected. The average % of particles of the various diameters removed (together with the probable errors of these %'s) are tabulated and graphed. These show that ca. 25% of particles of size 0.2μ and 80% of size 2μ are removed, and that between these 2 sizes the % removed is nearly proportional to the square root of the size. Above a size of ca. 3μ the % removal increases slowly until at a size of 5μ ca. 95% of the particles are removed.

The calculated displacements due to a combination of sedimentation and Brownian motion appear to be quite adequate to account for the removal of the particles. It seems the larger particles tend to be deposited in the larger air passages, while particles of decreasing size tend to be deposited in the smaller air passages. Owing to the subsequent expulsion of particles from the larger air passages by physiological mechanisms, the size distribution of the dust in the inhaled air may be some guide to the size distribution of the dust ultimately retained by the lungs.

471. von Oettingen, W.F.: Toxicity and Potential Dangers of Aliphatic and Aromatic Hydrocarbons. A Critical Review of the Literature. U.S. Public Health Service Bull. 255, 1940, 135 pp.

This critical review of the literature on aliphatic and aromatic hydrocarbons reports the physical and toxicological properties of the more common paraffins, olefins, diolefins, acetylene and its derivatives, cyclo paraffins, unsaturated cyclo paraffins, benzin, coal oil and benzene and its derivatives. A résumé is given after each class of aliphatic hydrocarbons. The toxicities of aromatic hydrocarbons and those of benzene and and benzin are compared. Extensive bibliographies follow both the aliphatic and aromatic sections.

472. **Flinn, R.H., Neal, P.A. and Fulton, W.B.: Industrial manganese poisoning. J. Ind. Hyg. Toxicol. 23:374-87, 1941.**

In an investigation of the health hazards in the Mn-producing industry, engineering and chemical studies were done to determine the degree of exposure in 2 Mn mills. 50 men were examined, 34 of whom were or had been exposed to MnO_2, the other 16 having had no known Mn exposure. 8 of the 34 men were somewhat disabled at the time of the study and did not work at the mills at that time. On the basis of the physical findings, particularly in the 11 cases of chronic Mn poisoning found, the typical signs of chronic Mn poisoning are discussed, with reference to differential diagnosis from: multiple sclerosis, paralysis agitans, Wilson's disease and syphilis of the central nervous system. There was evidence of extrapyramidal involvement of the central nervous system, including the basal ganglia, demonstrated in disturbances in gait and speech. The patients further showed twitching or tremor of the extremities and tremor of the tongue. Masked facies was observed in some cases, increased sensitivity of the Achilles tendon in others. Frequently, there was impairment of muscular strength, and occasionally, uncontrollable laughing and crying attacks were demonstrated by the patients. The blood count results showed the presence of leukopenia, the average number of leucocytes being 5,380, while 3 patients had $< 4,000$ leucocytes. With progressing disease, it was 4,300 or less in all cases. The average Mn content of the urine was 10 mg.✓/l. for the affected and 14 mg./l. for the exposed but nonaffected workers, the range being 4-48 mg./l. Mn was present in the urine as late as 19.9 and 7 yr. after the exposure, in the lungs at amounts of 4.87 mg./100 g. of dry tissue 7 yr. subsequent to exposure. If affected persons leave the exposure to Mn immediately after the onset of the described symptoms, the prognosis is favorable, although some sequelae may remain in gait and speech. Advanced Mn poisoning results in permanent disability particularly with regard to walking. Volumetric bismuthate analysis of air samples, taken in various plants, showed Mn to be present at the following concentrations: maximum 173 mg. $Mn/m.^3$, and average 40 mg. $Mn/m.^3$ in one plant; maximum 6 $mg./m.^3$, and average 2 $mg./m.^3$ in another plant. Precautionary measures for Mn dust control and problems pertaining to the medical supervision of the exposed workers are discussed.

473.✓ **Humperdinck, K.: Zur Frage der chronischen Einwirkung von Schwefeldioxydgasen. Untersuchungsergebnisse von Arbeitern einer Elektrongiesserei. (On the question of effects of chronic exposure to sulfur dioxide gases. Results of an investigation among workers in an electric foundry.) Arch. Gewerbepathol. Gewerbehyg. 10:4-18, 1941.**

A short review of publications on the action of SO_2 on the human organism shows that there are divergent opinions as to the dangerous concentrations. The following reported concentrations are presented, given as mg. SO_2/l. air: 0.08-0.13 tolerable over a prolonged period of time; 0.13-0.26 tolerable for 0.5-1.0 hr.; 0.12-0.3 tolerable for 1-3 min.; concentrations endangering the life of the exposed are: 0.4-0.5 after an exposure of 0.5-1.0 hr., and 1.0-1.3. Lethal effects have been produced by 0.36, 1.4 and 1.7. Following a short discussion of the typical symptoms of SO_2 poisoning, the author describes the exposure of the 87 foundry workers examined and the results of the examinations. The immediate inhalation of the SO_2 gas, present in the foundry in concentrations of 0.4 and 0.06 mg./l. air depending on the distance from the furnace, was prevented by its moving up with the hot air stream. Since the gas is 2.5 times heavier than air, it later sank down over the working area, where the inhaled air often had a SO_2 concentration of up to 0.06 mg./l. The following symptoms were

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found on examination of the 87 workers: chronic catarrh of upper respiratory tract and bronchi, cough, rales, frequently emphysema and, in acute cases, headache, nosebleed, conjunctivitis and gastric disturbances. Although there seems to be a certain adaptation to long-term exposure to SO_2, the chronic symptoms which are generally more disturbing than striking, may suddenly be interrupted by severe, acute exacerbations. Usually, however, complaints were more frequent and effects more severe in workers with short-term exposure. The following results of the blood examinations are reported: Means of 64 Hb counts, 16.54 g.; means of 19 blood counts, 16.63 g. for Hb, 5.16 million erythrocytes. The highest leucocyte and lymphocyte counts were found in the workers on night shift. Although the author's findings were somewhat more favorable than other reports on the inhalation of SO_2 gases, he states that in many cases seen, the symptoms indicate the possibility of further aggravation of the condition, and an increasing incidence of emphysema or bronchiectasis could be expected. Some precautionary as well as therapeutic measures are suggested.

474. National Institute of Health, Division of Industrial Hygiene: Hydrogen sulfide: its toxicity and potential dangers. Public Health Repts. (U.S.) 56:684-92, 1941.

The MAC for H_2S in the air has been established at 20 ppm by volume for exposures not exceeding 8 hr./day. H_2S occurs naturally in volcano gases, in waters of certain spas, in S-carrying brands of coal oil, in solution in H_2O or petroleum products, or wherever protein-containing materials are putrefying. The main sources of occupational exposure are the chemical, rubber and the rayon industries, where H_2S may be present in varying concentrations. Apart from occasional accidental ingestion and, infrequently, slow skin absorption, H_2S is absorbed and eliminated through the lungs, a small fraction being excreted with the urine as sulfide. Although, according to the tabulated data, the irritating action of H_2S begins only at 70 ppm, it is stated that even 15 ppm have been observed to cause irritation, increasingly so at 18-28 ppm. Even continued exposure to concentrations of less than 30-50 ppm does not result in systemic effects, whereas that to 500-700 ppm for a period of 1/2 - 1 hr. might endanger life. Inhalation of 5,000 ppm causes immediate death. At low concentrations of H_2S, the irritant action, and at high concentrations, its depressant action on the central nervous system predominate. The former affects the mucosae of the eyes, causing painful conjunctivitis, lacrimation, photophobia and, occasionally, corneal defects; it also acts upon the respiratory tract which may result in rhinitis, bronchial pneumonia or pulmonary edema. Continued exposure to low concentrations may bring about fatigue, headache, insomnia and irritability. High concentrations may result in sudden collapse and death from respiratory paralysis. Other effects reported are nausea, vomiting, anorexia and, following direct skin contact, erythema and hyperemia. Circulatory disturbances may remain as sequelae. H_2S reacts readily with methemoglobin to form sulfhemoglobin. It also interferes with the cell O_2 metabolism and is considered to have an initial hyper-, and subsequently, a hypoventilatory effect, corresponding to irritant and depressant action. The prophylactic and therapeutic measures to be observed in case of exposure to H_2S are discussed.

475. Neal, P.A., Dreessen, W.C., Edwards, T.I., Reinhart, W.H., Webster, S.H., Castberg, H.T. and Fairhall, L.T.: A Study of the Effect of Lead Arsenate Exposure on Orchardists and Consumers of Sprayed Fruit. U.S. Public Health Service Bull. 267, 1941, 181 pp.

This investigation is a study extending over 3 yr. of the possible injury to health of people exposed to Pb arsenate by inhalation of spray mist or dust (orchardists) and also by ingestion of fruit (consumers) and by other forms of exposure. This epidemiological study covered 1,231 men, women and children who live in an apple-growing region, viz., Wenatchee, Wash., where large quantities of Pb arsenate have been used for many yr. as insecticide sprays. Of these 488 were adult male orchardists and 54 female orchardists, and 158 men and 171 women were intermediate between orchardists and consumers. In the region in which these persons lived and worked, Pb arsenate has been used for codling moth control since about 1900. During the 1938 season, as many as 10 cover sprays were applied in apple orchards, usually 3 lb. Pb arsenate/100 gal. of H_2O and from 40-50 gal. of spray/tree/cover. Mixing spray materials involves an average exposure of 57.4 mg. Pb/10 $m.^3$ air and 18.5 mg. As/10 $m.^3$ air (as Pb arsenate). Spraying, which may be a full-time or part-time activity exposed orchardists to an average atmospheric concentration of 4.5 mg. Pb/10 $m.^3$ air and 1.4 mg. As/10 $m.^3$ air. Other orchard activities involved average Pb and As exposures of 35.8 mg. Pb/$m.^3$ and 166.7 mg. As/$m.^3$ for burning containers, 3.0 and 0.8 for thinning, 29.3 and 8.8 for picking, 1.1 and 0.35 for dumping and 0.16 and 0.06 for sorting and packing. The orchardists ranged in age from 15-84 but were predominantly from 25-64. The medical examination consisted of a detailed occupational history, past and present medical histories, a complete initial physical examination and 1-2 reexaminations. 6 male orchardists and 1 woman who tended tanks (aged 23-68 yr.) had a combination of clinical and laboratory findings referable to absorption of Pb arsenate and diagnoses of low-grade Pb arsenate intoxication were made. In all cases it cleared up spontaneously by the time the patient came in for the next examination. The distribution of the Pb and As content of the urine and the Pb content of the blood were compared from month to month for male consumers and for male orchardists except for Feb. and Mar. and for Aug. and Sept. when the values were determined for female consumers and orchardists. There is little variation in the male consumers' values from month to month, but a rise in the male orchardists' values is shown from May-July, the spraying season, reaching possibly a peak in Aug. or Sept., for which there are no figures. The values were lower again in Oct. and reached a low in Mar.-Apr. The data for female consumers and orchardists only show that the values for the orchardists were always higher in Aug.-Sept. than in Feb.-Mar. Further study shows that the blood Pb and urinary Pb and As values of the former orchardists fell to the levels of men who never had an unusual exposure to these metals. A study of the health of 99 Wenatchee boys and girls under 15 showed that their urinary Pb and As values were, on the whole, higher than those of the adult consumers, but that their general health was just as good as non-Pb arsenate-exposed children. The possibility of a relation of other diseases and abnormalities, e.g., loss of weight, cardiovascular disturbance, blood pressure, skin disorders, eye irritation, chronic nervous diseases, blood dyscrasias, kidney diseases, perforated nasal septum, pulmonary tuberculosis, acuity of vision, blindness, syphilis and neoplastic diseases, to Pb arsenate exposure is discussed.

476. Thorp, C.E.: Influence of nitrogen oxides on the toxicity of ozone. News Ed. Am. Chem. Soc. 19:686-8, 1941.

A series of tests in which human subjects, mice, β-coli aerogenes, flour weevils and algae were exposed to various concentrations of 100% O_3 in air and of 47% N oxides and 53% O_3 in air ranging from 0.01-100 ppm of the total gases are described. The former was produced by the common metal-glass-metal type of ozonizer using a brush discharge, while the latter was produced by O_3 equipment using the perfected generating elements. Tests on 4 men showed that the toxic limit for O_3 containing 47% N oxides is 1 ppm which is equivalent to ca. 0.5 ppm N oxides. At 20 ppm of pure O_3, 4 hr. exposure produced no soreness of nose or throat; at 100 ppm 1 min. exposure dried the skin and produced severe sore throat. For mice the lethal concentration of impure O_3 was found to be 10 ppm and of pure O_3, 50 ppm. Tests on β-coli show that at 30 ppm O_3 with 47% N oxides kills all coli in H_2O when coli are less than 220/cc., 5 hr. aeration/l. Only 20% of the coli in H_2O containing 500/cc. are killed by 100 ppm pure O_3 at 1 hr. aeration/l. Flour weevils were killed after 30 min. aeration at 50 ppm impure O_3. Algae were killed by 15 ppm impure O_3 after 10 min. bubbling through H_2O; pure O_3 did not kill the algae.

477. von Oettingen, W.F.: Toxicity and Potential Dangers of Nitrous Fumes. U.S. Public Health Service Bull. 272, 1941, 34 pp.

This is a review of the physical and chemical properties, the physiology, toxicology, pathology of and animal exposure to N_2O, NO and NO_2. NO_2 is reviewed in great detail. (122 references.)

478. Yant, W.P., Levy, E., Frevert, H.W. and Marshall, K.L.: Carbon Monoxide and Particulate Matter in Air of Holland Tunnel and Metropolitan New York. U.S. Bur. Mines Rept. Investigations 3585, 1941, 69 pp.

The CO and particulate matter (PM) in the air of the Holland Tunnel and in the air of metropolitan New York at various places both at and away from the tunnel were studied to determine whether the tunnel had a significant effect on these contaminants in the atmosphere in the immediate vicinity. The study was started in Apr. 1932 and continued at intervals until Feb. 1933. PM was studied at 2 seasons of the yr., spring (Apr.-June 1932) and winter (Feb. 1933). CO was studied during Aug. and Sept. 1932. Concentration of CO tends to vary with the traffic through the tunnel and in different parts of the tunnel; it was highest in the exit or upgrade section. Concentration in the spring in the upgrade section (average daily traffic 15,000 cars) averaged ca. 160 ppm during the high-traffic hr. (8 a.m. - 8 p.m.); in the winter, 110 ppm (average traffic 11,000 cars). At all seasons, CO concentration between 8 p.m. and 8 a.m. averaged ca. 50 ppm. From 11:30 a.m. - 10:30 p.m. on spring Sundays (average traffic 20,000 cars), CO averaged 170 ppm. Pb content of both suspended and deposited material collected from the intake part of the tunnel was lower than that of the material from the exhaust (0.04 and 0.9% in suspended material). Arsenic was higher in material from the intake than from the exhaust (0.044 and 0.016% in suspended material). Deposited material from the intake contained less volatile matter than that from the exhaust (27 and 57%). The composition of the volatile matter and ash in material from intake and exhaust was similar. Concentration of PM in the air of the south tube and in the discharge did not exceed that in the intake air until traffic reached 300 cars/hr. and CO 40 ppm. Concentrations of tunnel-added PM varied directly with CO. The amount of tunnel-added PM in the discharge air was ca. 7 grains/car.

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The tunnel air contained ca. 1500 million microscopically visible particles/mg. PM. The size of particles collected from intake air was similar to those from exhaust air (geometric mean, 0.41 and 0.40 μ); there were no significant differences in different seasons. Results of 46 determinations of weight concentration of PM in the intake air of the tunnel ranged from 0.00-0.82 mg./m.^{3}, with an average of 0.30. Weight concentration in spring was higher than in the winter. In 1 section spring concentration was 0.49-0.86, average 0.66 mg./m.^{3}. Concentration of tunnel-added CO and PM in the discharged-air streams fell to ca. 10% of that at the stack discharge within 30 ft., to ca. 6% within 100 ft. and 2% within 150 ft. The concentration of CO and PM in the air in the immediate vicinity of the tunnel did not differ significantly from that in the air in other parts of metropolitan New York.

479. Barnes, E.C. and Speicher, H.W.: The determination of formaldehyde in air. J. Ind. Hyg. Toxicol. 24:10-7, 1942.
Methods of sampling CHOH in air by collecting in a 1.25% KOH solution and of determination by the use of a dropping Hg electrode and by a colorimetric chemical procedure are described. In the course of checking the sampling apparatus the authors were exposed to 20 ppm CHOH for short lengths of time. At this concentration lacrimation and irritation of nose and throat membranes were noted in 15-30 sec. after exposure. Sneezing also occurred within 1-2 min. Exposure could be continued for some length of time but was distinctly uncomfortable. In the evaluation of possible health hazards in workrooms, workmen exposed to <10 ppm CHOH complained of irritation, while no complaints were made at <5 ppm CHOH.

480. Beck, H.G.: A study of the effects of combustion products of natural gas upon public health. New Orleans Med. Surg. J. 94:361-9, 1942.
A clinical survey was made of CO inhalation cases. A preliminary analysis of 150 cases previously studied showed the symptoms to be the following: headache, weakness, vertigo, nervousness, dyspnea, paresthesia, muscular twitching, emotionalism, nausea, drowsiness, unsteady gait, neuromuscular and joint pains, tremor, muscular cramps, cough, sweats, vomiting, insomnia, anorexia, precordial distress, vasomotor instability, perversion of taste and smell, speech defect, impairment of hearing, hoarseness and yawning. The clinical survey was made from Jan.-Feb. 1940 and included 279 cases of people living in 125 homes and shops. In 78 of the premises, 1 or more appliances were producing CO. 21% of all the appliances (784) were discharging CO into the room in concentrations of ≧300 ppm in 10% of the cases, ≧750 ppm in 5% and ≧1500 ppm in 3%. 142 persons were asymptomatic as far as the effect of CO was concerned. 137 gave a history of either existing or pre-existing symptoms suggestive of CO anoxemia. In the 1st group 101 individuals never experienced any symptoms attributable to CO and therefore no blood determinations for CO were made. In 38 cases, tests were made both for escaping CO from defective appliances and for CO in the blood. 15 cases showed no CO in the blood; these were exposed to ≦50 ppm CO. In 8 cases there was maximum exposure of 100 ppm CO and <5% found in the blood. In 16 cases, the maximum exposure was 250 ppm CO, with 5-8.7% found in the blood. In the 2nd or anoxemic group, the majority of the patients were classified as having simple uncomplicated anoxemia that affected the following systems: central nervous and neuromuscular, cardiovascular, gastrointestinal, urogenital, ophthalmologic and hematologic. The rest were classified as having CO anoxemia with associated coexisting diseases or CO anoxemia with complications and sequelae. The detailed results of the blood studies are also given.

481. Gardner, L.U.: Respiratory irritants - dusts, fumes and gases. In: Tuberculosis in Industry. Report of the Symposium Held at the Saranac Laboratory for the Study of Tuberculosis, Saranac Lake, N.Y., June 9-14, 1941, N. Y. National Tuberculosis Association, 1942:115-22.

The author states that, in contrast to popular and even professional belief, there is sufficient evidence indicating that the mere presence of inflammatory reaction in lung tissue does not alter native reaction to the t.b. bacillus by purely mechanical means. There is no proof that local inflammation favors the implantation of t.b. bacilli nor does it necessarily bring about dissemination of infection from a pre-established focus of t.b. On the basis of both clinical experience and that obtained from animal experiments, the author discusses the influence on the incidence of t.b. of pulmonary reactions to: tuberculin, lobar pneumonia, free SiO_2 and asbestos, various fumes and gases, such as Cl, SO_2, HF, combinations of $COCl_2$ with $POCl_3$ and PCl_3. Exposures occurring in nonferrous mines, metal smelters and sulphite cellulose plants are mentioned from the same point of view, as well as those encountered in arc welding. In conclusion, the author states that the significant factors responsible for the unfavorable course of a t.b. process are more likely chemical in nature and only created by a limited number of specific irritants. In the category of such irritants we now recognize free SiO_2, tuberculin and possibly the virus responsible for influenza. None of the evidence available at the present time indicates that dusts other than free SiO_2, either in pure state or as a contaminant of other materials, or any of the more common industrial fumes or gases have specific action in altering susceptibility to t.b.

In the discussion, various additional aspects of the problems are covered, e.g., the possible role of starch or of necrotizing gases in the predisposition to or promotion of pulmonary t.b., but the author reiterates his opinion as expressed above.

482. Sievers, R.F., Edwards, T.I. and Murray, A.L.: A Medical Study of Men Exposed to Measured Amounts of Carbon Monoxide in the Holland Tunnel for 13 Years. U.S. Public Health Service Bull. No. 278, 1942, 74 pp.

The results of this investigation are contained in the abstract of Sievers, R.F., Edwards, T.I., Murray, A.L. and Schrenk, H.H.: Effect of exposure to known concentrations of carbon monoxide. A study of traffic officers stationed at the Holland Tunnel for thirteen years. J. Am. Med. Assoc. 118: 585-8, 1952. The original report, of course, is more complete than the J.A.M.A. article in that it describes the investigation in detail and gives the sources of the comparison studies. An investigation of the toll collectors after an 8-hr. day of very heavy exposure showed concentrations of CO in the blood ranging up to 15.1% (% hemoglobin combined with CO). CO concentrations in the blood of tunnel officers ranged from 0.5-13.1%. No effects attributable to CO exposures were noted in either case. Measurements of CO concentrations in industry in the vicinity of a great variety of operations emitting CO show that most of these exposures fall within the range of this investigation.

483. Sievers, R.F., Edwards, T.I., Murray, A.L. and Schrenk, H.H.: Effect of exposure to known concentrations of carbon monoxide. A study of traffic officers stationed at the Holland Tunnel for thirteen years. J. Am. Med. Assoc. 118:585-8, 1942.

An examination of a group of 156 Holland Tunnel traffic officers exposed throughout a period of 13 yr. to an occupational CO exposure averaging 0.7

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parts CO/10,000 parts air (70 ppm) was made. Infrequently the concentration exceeded 2.0 parts /10,000 and rarely 3.0 parts/10,000 for brief intervals. Half of the 156 men were on regular duty, i.e., their four 2-hr. periods alternated between tunnel duty and traffic duty on the plazas at the entrances and exits of the tubes. The CO concentration under these latter conditions was negligible. Other officers were stationed in emergency garages where no CO could be demonstrated in the air; others were assigned to desk duty and still others to duty outdoors. Most officers were symptom-free; when complaints of ill health were made they tended to be nonspecific and to occur singly. Nor were significant neurologic changes, e.g ., 1) unilateral inequality of individual reflexes, 2) tremors and 3) neuromuscular incoordination demonstratable in the group. Laboratory examination of the blood showed that the levels of CO in the blood of nonsmoking traffic officers stationed in the tunnel during 2 hr. of average exposure fell within the same range of CO-hemoglobin values found in cigarette smokers with no occupational exposure to CO. From a roentgenographic study, it was concluded that the hearts of these men had not been damaged by conditions associated with their employment. A tentative diagnosis of heart disease on the basis of a number of findings, e.g., irregular pulse, elevated blood pressure, enlarged heart and abnormal electrographic tracings, was established on 4 men; this is not an uncommon rate of incidence in employed populations. Thus no evidence of injury to health attributable to CO exposure was revealed.

484. Cholak, J. and Bambach, K.: Measurement of industrial lead exposure by analyses of blood and excreta of workmen. J. Ind. Hyg. Toxicol. 25:47-53, 1943.

Industrial exposure to Pb causes a definite increase in the mean Pb concentration of blood, urine and feces of the exposed workers, and elevation of the former two is indicative of the degree of the exposure. A comparison of the mean values obtained from groups of nonexposed persons with those from workers representative for various exposure to Pb in a plant may show the uniformity or the severity of the hazard present. By collating the results of periodic examinations of workers from different plants in the same industry, changes in exposure can be detected and the efficacy of hygienic measures can be controlled.

Analyses of blood, urine and feces were carried out by both the spectrographic and the dithizone methods, their suitability gauged by comparison of the values obtained polarographically in tissue analyses. The figures were in good agreement. The following Pb values were obtained from normal, exposed persons: in blood (mg./ 100 g.) : mean, 0.030, ranges, 0.023-0.038; in urine (mg./l.): mean, 0.027, ranges, 0.021-0.038; in feces (mg./24 hr.): mean, 0.27, ranges, 0.244-0.436.

From the tabulated mean values for the Pb contents of blood, urine and feces of groups of both nonexposed persons and those with varying degrees of exposure, it is apparent that the rise of the urinary Pb is the most regular. Only in cases of Pb uptake predominantly by way of inhalation, the fecal Pb contents were most indicative.

The described analyses were done of samples collected from the following 4 groups: nonexposed persons, garage mechanics, men manufacturing tetraethyl lead and men engaged in the production of lead shot. The following percentage showed urinary Pb values of at or below 0.04 mg./l.: 90, 50, 14 and 5%, respectively, in the sequence of the groups listed above. In blood, Pb values of at or below 0.04 mg./100 g. were detected in 90, 80, 50 and 18%, while in the feces, Pb contents of at or below 0.45 mg./24 hr.

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were found in 92, 65, 70 and 17% of the 4 groups.
The advantages of setting up the analytical data in form of histograms are discussed and illustrated.

485. Dreessen, W.C.: Health of lead-exposed storage battery workers. J. Ind. Hyg. Toxicol. 25:60-70, 1943.
An extensive investigation, carried out by the U.S. Public Health Service, included the following phases: a preliminary survey of 26 storage battery manufacturing establishments, environmental studies in 13 and medical studies in 6 plants. 360 air samples were collected, averaging 6 m.^{3} each, which were analyzed by the modified Fairhall method (volumetric chromate method). The great variations in exposure to Pb are reflected in the figures (given throughout in mg. Pb/10 m.^{3} air): about 50% of the workers were exposed to >1.5 (i.e., to >MAC); smelters, 0.1-19.2; pasters, 1.2-88.0; oxide mixers, 0.8-36.9 and group assemblers, 1.0-28.5. Generally, the hazard was reduced by good hygienic control. Medical examination of 766 workers, ranging in age from 20 to >60 yr., revealed that 177 had "early plumbism": 168 had abnormal Pb absorption, 9 showed incipient plumbism. The incidence did not depend on duration but on severity of exposure, i.e., this disease occurred in 54% of those exposed to >3.0 but only in 4% of those exposed to <0.75. The laboratory findings may be summarized as follows: 6 men had an erythrocyte count of <4,000,000/cc. of blood, 16 had >100, 1 had 750 stippled cells/100,000 erythrocytes. For men exposed to Pb concentrations of >3.0, the values for reticulocytes ranged from 2.54% to 3.90%. The averages for Hb, given in mg./100 cc. of blood, were: nonaffected workers, 12.9; affected, 11.6 (ranges: 8.0-17.0) and for the 9 men with incipient plumbism, 9.5. Albuminuria was found in 115 (= 15%) of the 766 men examined: in 12.2% of the nonaffected and in 24.3% of the affected workers. The Pb contents of the blood (µg./100 g.) are given in relation to exposure or effects: at exposure to Pb concentrations of <0.75, nearly all Pb blood values were <40; but 11 workers, 8 of which had "early plumbism," showed ranges from 100 to 253; in the blood of 12, 8 of whom were not exposed to Pb, the latter was not present. All men with Pb blood values of >100 had Pb urine values exceeding the maximum of 0.17 mg./l. found in the nonexposed. High Pb contents of blood and urine were indicative of other Pb-induced changes. The prevalence of arterial hypertension and arteriosclerotic-hypertensive cardiac disorders, as well as the incidence of other diseases were similar to those observed in other industrial workers. The significance of strict hygienic control, particularly where exposures exceed the MAC (i.e., 1.5 mg. Pb/10 m.^{3} of air), is stressed.

486. Drinker, P., Yaglou, C.P. and Warren, M.F.: The threshold toxicity of gasoline vapor. J. Ind. Hyg. Toxicol. 25:225-32, 1943.
Human subjects were exposed to low concentrations of gasoline vapor for 8 hr., with 1 hr. out for lunch, at average temperatures of 74-75°F. and ca. 20% humidity. The subjects read, worked or played cards during this time. 13 men were exposed to 0.027% and 8 women to 0.016% commercial gasoline vapor. All detected gasoline on entering. Irritation of the eyes and throat were the most distinctive symptoms, but were not severe. These 8 women were also exposed to 0.015%, and 10 college girls to 0.014% distillate from commercial gasoline. Irritation of the eyes was the most frequent complaint of the women; it was less than for the whole gasoline. The college girls reported their complaints without any leading questions to guide them. Only 1 reported slight eye irritation and 3 a cough or

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irritation of the throat. In these experiments, 1 or 2 also noticed some gastrointestinal disturbance. Tests were also carried out on 2 men and 7 women in which gasoline vapors at very low concentrations were blown directly over the eyes through a pair of goggles. All agreed that vapor from whole commercial gasoline was unbearable; that vapor from the distillate (below 100°C.) was unpleasant but not nearly so irritating as from the whole gasoline and that the residue gave a detectable irritation that could have been tolerated indefinitely. 3-9 men and, in 2 cases, 1 woman were exposed for $\leqq 1$ hr. to 0.05, 0.09, 0.26 and 1.07% commercial gasoline distillate and to 1.12% whole commercial gasoline under conditions similar to the above. At 0.05% there was no significant complaint. At 0.09% eyes, nose and throat irritation was extremely slight, but beginnings of neuromuscular symptoms at the end of the hour, e.g., slight dizziness, nausea and headache, were noted. 0.26% caused slight amount of muscular incoordination and lightheadedness, but there were no unpleasant aftereffects. 1.07% produced intoxication in from 4-7 min. and the effects were identical with those from alcohol and ether, but were not unpleasant either at the time or afterward. 1.12% whole commercial gasoline caused dizziness and a feeling of incoordination and drunkenness after 5-5.5 min. Though the physiologic effects of the whole gasoline and the distillate were similar, the latter was less irritating to nose and throat.

487. Goldburgh, H.L. and Gouley, B.A.: Sulfur dioxide chemical pneumonia; report of case with recovery following accidental explosion of refrigerator unit. Ann. Intern. Med. 18:237-42, 1943.
The danger of exposure to SO_2 in the refrigeration industries is cited as an example of the increasing exposure of workers to various noxious gases. The authors seek to exemplify in this report (1) the rapid destructive effect of concentrated SO_2 inhalation and (2) the apparently beneficial results of sulfonamide therapy in such cases. The action of SO_2 is similar to NO_2, which is corrosive to the moist mucous membranes. The greatest damage is in the bronchi and bronchioles with erosion of the lining epithelium, deciliation, edema of the underlying submucosa, spasm of the bronchial muscle and thrombosis of the small arteries and veins. With inhalation of concentrated fumes, the acute process extends into the alveolar ducts and the alveoli. In the alveoli the inflammatory exudate consists of fibrin and plugs of desquamated cells resembling a picture of the so-called lobular catarrhal pneumonia. During recovery, regeneration takes place with difficulty with the possibility of the development of bacterial infiltration and possibly the development of bronchiectasis, bronchial asthma and chronic bronchitis. It is doubted that recovery is ever complete following acute SO_2 inhalation. In the case cited, a boy, age 15, previously well, was exposed to a high concentration of SO_2. Acute evidence of bronchopulmonary involvement was quickly present. Cyanosis and dyspnea were present. Sulfathiazole is given large credit in recovery, but it did not prevent the development of bronchiectasis. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

488. Gordon, J.: Acute tracheobronchitis complicated by bronchial stenosis following the inhalation of sulfur dioxide. N. Y. State J. Med. 43:1054-6, 1943.
The case of an electrical repairman, 44, who inhaled some SO_2 refrigerant for a few minutes is reported. The concentration of the SO_2 was not reported. The physiological data and the toxicological effects are reviewed in detail. The illness of the patient began with a mild infection

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Gordon, J. (continued)
of the upper respiratory tract, followed by exposure to SO_2 gas, resulting in acute tracheobronchitis. Clinical improvement was obtained during the first admission with bronchoscopic aid. Some months later, the patient again inhaled SO_2 in the fumes of coke, and the acute attack of tracheobronchitis that followed this exposure terminated in a partial stenosis of the left main bronchus.

489. Pinto, S.S., Brown, R.A. and Carlton, B.H.: Study of industrial workers exposed to sulfur dust. J. Ind. Hyg. Toxicol. 25:149-51, 1943.
How S is mined in Europe and in the U.S. is briefly reviewed. The miners in Europe are much more exposed to S dust than in the U.S. Studies of the average and peak dust counts around each loading operation in which S dust was generated were made in a S mine in the U.S. The dust counts ranged from 0.6-0.8 to 100.0-206.0 million particles/$ft.^3$. Chest X-rays of 500 workers, both exposed and not exposed to S dust, were taken. It was found that even among the workers exposed to appreciable amounts of S dust for a period of 7 yr., no lung lesions were found on X-ray examination which could be attributed to the inhalation of S dust. However, the published results of similar studies in Europe show contradictory findings.

490. Schwarz, L. and Deckert, W.: Über Arsen in den Haaren und einige andere Befunde bei erkrankten Arsenarbeitern. (On arsenic in hair and some other findings in diseased arsenic workers.) Arch. Hyg. Bakteriol. 129:276-85, 1943.
The tabulated findings obtained from the examination of 25 workers in the As producing industry, ranging in age from 31 to 41 yr., include general symptoms resulting from the exposure to As, skin lesions and the As content of the urine. Special significance is attributed to the differences in the As content of short (young) neck hair, the longer (older) hair on the head and the pubic hair as indication of the degree and time of absorption of As. The exposure times of the examined workers ranged from 12 da. to 4 yr., the time intervals between the last exposure and the examination from 7 da. to 8 mo. The group included one worker who had not left his job. The values for the As content of the urine ranged from 20γ to 6,400γ/g. As was detected in the hair at the following concentrations: scalp hair, 10-920γ/g.; neck hair, 10-1,600γ/g.; pubic hair, 40-2,100γ/g. The As content at these 3 sites was not necessarily uniform. A high As content of the neck hair, however, demonstrates the absorption of considerable amounts of As shortly prior to analysis. The blood findings of the 25 workers were not consistent, as had repeatedly been reported in cases where As-containing medications had been administered. No anemia was found; 7 workers having left the exposure for periods ranging from 7 da. to 3.5 mo. had increased erythrocyte values, 2 had leukopenia, the number of leukocytes being reduced to 3,380 and 3,430, respectively. 2 others had increased leukocyte values: 12,000 and 12,700, respectively. About 1/3 of the examined group had relative lymphocytosis with values ranging from 37.3 to 51.0%, 1/5 had monocytosis, demonstrated by these values: 10.5 - 16.0%. It is concluded that deviations from the normal blood values are indicative of a general toxic effect of As.

491. von Oettingen, W.F.: Carbon Monoxide: Its Hazards and the Mechanism of Its Action. U.S. Public Health Service Bull. 290, 1944, 257 pp.
This extensive review of CO includes its physical and chemical properties, determination in air and blood, sources of exposure, concentration in air, relationship of concentration and toxic symptoms, role and fate in the body, clinical picture of acute CO poisoning, chronic poisoning,

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von Oettingen, W.F. (continued)
effect of poisoning on the resistance to infections, pathology from poisoning expecially with respect to vascular changes and O_2 metabolism in the nervous system, mechanism of poisoning, variations in susceptibility to CO, habituation to exposure, synergistic factors in poisoning and prophylaxis and treatment of poisoning. An extensive 48 page bibliography of approximately 1200 references is included.

492. Noro, L.: Carbon monoxide poisoning. Nord. med. 26:771-6, 1945.
The author describes the clinical picture and pathogenesis of CO poisoning and the existence of the poisoning in drivers of motor cars operated by charcoal gas in Finland. Of the 5,000 drivers, who were questioned, symptoms of CO poisoning were found in 67.5% of the cases. The symptoms of acute poisoning were complained of by 3,069; symptoms of chronic poisoning, by 2,506 drivers. In 530 cases the poisoning had caused inability to work. In Finland at present, CO poisoning is the most common occupational disease. (Abst. Atmos. Poll. Bull. 14:16, 1946.)

493. Rubin, H.H. and Arieff, A.J.: Carbon disulfide and hydrogen sulfide clinical study of chronic low-grade exposures. J. Ind. Hyg. Toxicol. 27:123-9, 1945.
A clinical study was made of 100 workers exposed to CS_2 and H_2S under controlled working conditions. 78 were on rotating shifts and 22 were on maintenance day shift. Ages varied from 25-58 yr. and length of employment from 3 mo.-17 yr. Air samplings, made over the 4-yr. period prior to this, i.e., 1941-44, showed that H_2S ranged in concentration from 1.0-4.0 ppm and CS_2 from 1.9-26.4 ppm. 32% of the group were fatigued at the end of the day's work and 22% felt tired on awakening. However, in a control group of 55 workers, the corresponding figures were 34.5% and 23.6%. 16% of the exposed workers revealed diminished or absent corneal reflexes, usually an important diagnostic symptom, and 6% had diminished pupillary reflexes. But 12% of the controls also had diminished corneal reflexes. Abdominal, cremasteric and plantar superficial reflexes were decreased in 21. 8 individuals revealed pathological reflexes, but none was found to have a complete pathological syndrome. One showed a decreased tendon reflex. 23 revealed increased deep reflexes bilaterally equal in 4 extremities, 6 of which had associated decreased superficial reflexes. Tremors were not significant. Though 7 of the workers showed decreased arm swinging or associated movements, there was none with other findings indicative of Parkinsonism. Diminished hearing occurred in 16. In no case was there any evidence of organic involvement implicating the peripheral or central nervous system. Actually shift work as a causative factor rather than the toxic effects of CS_2 and H_2S in the particular working environment showed the highest correlation with subjective complaints. The many signs and symptoms elicited seem to be deviations from the average rather than indications of pathology.

494. Van Ordstrand, H.S., Hughes, R., DeNardi, J.M. and Carmody, M.G.: Beryllium poisoning. J. Am. Med. Assoc. 129:1084-90, 1945.
A disease encountered in 170 workers in 3 Be-producing plants in the Cleveland area is discussed. It was characterized mainly by dermatologic and respiratory manifestations. The specific etiology of Be poisoning is unknown, but its occurrence following exposure during the extracting of BeO from the beryl ore, the absence of appreciable fever and of pathogens in the bronchial secretions, as well as normal sedimentation rates and blood count values indicate its chemical nature. Workers from all types

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Van Ordstrand, H.S. et al. (continued)
and phases of production were affected, the frequency and severity depending upon the degree of exposure to Be and its compounds, i.e., radical salts, etc. 42 patients demonstrated cutaneous symptoms in form of contact dermatitis or ulcers. Signs characteristic for the former were: edematous, papulovesicular eruptions on the exposed body portions, intense pruritus, burning, weeping, occasional conjunctivitis. Removal from the exposure, and therapy induced healing without complications or sequelae. Ulcers developed usually singly and only on injured skin, in the form of a small, indurated papule, surrounded by an erythema which later necrotized. In the early stage, therapy was incision of the papule and curettage of the fibrous base; in advanced cases, the embedded crystal has to be excised. Patients with chemical dermatitis may develop chemical bronchitis and/or pneumonitis, unless they leave the exposure. The cutaneous reaction serves as indication for the degree of susceptibility to respiratory irritation. 90 patients were seen with nasopharyngitis and/or tracheobronchitis, mainly resulting from the exposure to hydrous Be sulfate and anhydrous Be fluoride and Mg. Characteristic for nasopharyngitis are the absence of cough, the presence of epistaxis, swelling and, occasionally, of fissures of the nasal mucosa. Therapy was prophylactic and symptomatic. As typical symptoms for tracheobronchitis, the following are mentioned: cough, rales in both lungs, normal X-ray findings and, in dyspneic cases, a reduction (up to 30%) of the vital capacity. Chemical pneumonitis developed in 38 workers, followed without exacerbation or remission by either complete recovery or death. Case reports are presented illustrating: the occurrence in different types of jobs, the recurrence upon re-exposure, the variability of symptoms and the importance of rest therapy. As typical symptoms, the author mentions the following: productive, sometimes bloody cough, substernal pain, dyspnea, respiratory rates up to 40/min., vital capacity reduced to as low as 2,000 cc., cyanosis, rapid pulse rates, abnormal taste, anorexia, weight loss of up to 14 lb., increasing fatigue but normal sedimentation rates. The various stages of roentgenologic lung changes are discussed, from haziness over infiltrations, their absorption, formation of nodules and clearing of the fields within 1-4 mo. Results from necropsies of the lungs of 5 patients (exposure times 40 da.-10 mo.) are given. Wet lung tissue contained (in mg./10 g.): 0.03-0.33, dry tissue: 0.19-1.89 Be.

495. Watrous, R.M. and McCaughey, M.B.: Occupational exposure to arsenic--in the manufacture of arsphenamine and related compounds. Ind. Med. 14:639-46, 1945.

The chemical manufacture and packaging of arsphenamine and related compounds are attended by the escape of dust in many different stages. The amount of As in this dust in 1 pharmaceutical plant was determined by analyzing 31 air samples. Values ranging from 0.0002-0.017 mg.As_2O_3/ft.^{3} (0.007-0.60 μg./l.) were found. The mean value for all manufacturing operations was 0.006 mg./ft.^{3} (0.17 μg./l.); the mean for the packaging operations was 0.0023 mg./ft.^{3} (0.065 μg./l.). The urinary excretion of 17 manufacturing workers and 10 packaging workers was determined on 1 or more occasions. The values were compared with those obtained in 13 applicants for work (presumably unexposed to any As). The range for manufacturing workers was 0.006-0.500 mg./100 cc. of urine; mean, 0.059. For packaging workers: range, 0.003-0.037; mean, 0.014. For normal controls: range, 0.006-0.028; mean, 0.017. Thus, the urinary excretion reflected no absorption of organic arsenical dust in the packaging department. In the manufacturing department, urinary excretion increased roughly in

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Watrous, R.M. et al. (continued)
proportion to the magnitude of the exposure. Only a fraction of the calculated inhaled As could be demonstrated in the urine. Analysis of hair in 5 manufacturing workers in 1942 gave values ranging from 300-2000 µg. As_2O_3/g. washed hair; similar analysis of 3 manufacturing workers in 1945 gave 220-400 µg. These values are higher than those previously reported in the literature. But they were not accompanied or preceded by any symptoms of As poisoning, or by unusually high As values in the urine. The As is believed to be of external origin (settled dust, etc.), and to have no diagnostic value. Clinical judgment, based on frequent contact with the exposed workers over the entire period of exposure, did not give the impression that any symptoms of As poisoning existed except in a few isolated workers in the manufacturing department during a short period of unusually heavy exposure. This was verified by a detailed analysis of the medical records of 35 manufacturing workers, 31 packaging workers and 30 unexposed controls, in which all complaints which might be attributed to arsenical poisoning were tabulated and compared with similar complaints by unexposed workers. Case reports of 3 workers showing transitory symptoms of borderline As poisoning are presented. An analysis of 323 periodic complete blood counts in workers exposed to arsenical compounds and 221 counts in unexposed workers doing otherwise similar work revealed no evidence of myelotoxic effect due to arsenicals. (Condensed authors' summary.)

496. Davies, T.A.L.: Manganese pneumonitis. Brit. J. Ind. Med. 3:111-35, 1946.
Mn acts in 2 ways: (1) by changing the central nervous system, (2) by causing pulmonary symptoms commonly termed manganese pneumonia. The present tests resulted from the observation that men exposed to the inhalation of dust of MnO_2 and higher oxides of Mn, suffered a higher incidence of pulmonary symptoms than the normal population. The incidence of pneumonia in a group of 40-124 men, exposed to the inhalation of Mn dust, varied from 15-63 (average 26)/1000 over the years 1938-45 inclusive, compared with an average of 0.73/1000 for 1938-44 amongst the male members of an insurance company used as a control. A new dust-feed apparatus was designed for the regulation of amount of Mn dust inhaled by mice. Tests were run for various periods of inhalation; then the mice were injected or exposed to pneumococci of various types. The temperature was kept at 65°F. in the inhalation chamber. The results did not suggest that inhalation of Mn increases susceptibility for pneumonia. After inhalation of MnO_2 dust, although some particles may be phagocytosed, all particles pass into solution in the tissue fluids after inhalation. Mn is toxic to the respiratory epithelium, and exerts a specific chemical action, which in mice results in an intense mononuclear proliferation and infiltration of the lung tissues, and as the action of the Mn proceeds, in cellular death and necrosis. Mn dust may affect any part of the respiratory tract. Further investigations are needed to confirm the theory suggested by these experiments, that Mn dust has a specific action on the human lung.

497. Currie, A.N.: The role of arsenic in carcinogenesis. Brit. Med. Bull. 4:402-4, 405, 1947.
The arsenical risks in industry are discussed, e.g., the risk of pulmonary cancer and other lung diseases in the mining of Co arsenide and other arsenide ores in the Schneeburg area. No lung cancer among Cornish tin miners is recorded in Britain. Cases of lung damage along with keratosis of the skin and pigmentation occurred in a factory in England making sheep-dip from white As and S. Arsenical cancer is also reported

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Currie, A.N. (continued)
among other sheep-dip workers. As may also contribute to cancer among farmers, gardeners and nurserymen, since it occurs in soot and fertilizers. The "arsenic theory" of other forms of industrial cancers, viz., mulespinners' cancer, shale cancer, pitch and tar cancer and cancer of the urinary bladder, is discussed and generally disproved. The signs of chronic arsenicism, viz., hyperpigmentation or melanosis of the skin and keratoses, which may precede arsenical skin cancer are discussed. Non-industrial arsenical intoxication, in some instances developing cancer, owing to a relatively high concentration of As in the public H_2O supply, occurred in Reichenstein (Silesia) and Cordoba in Argentina. Experimental painting and feeding of As to animals led to indeterminate results, principally because of a rather high toxicity of As, which did not permit the animals to live long enough to become precancerized. It is concluded that it is difficult to assess the function of As in the production of malignant change. It may act as a chronic protoplasmic irritant directly stimulating epithelial proliferation, or, because of its profound effect on cell oxidation, it may bring about an intracellular chemical breakdown liberating organic substances which are known to produce cancer experimentally. These substances may act at the site of their evolution or may be transported to distant parts to effect in time malignant change at their ultimate destination. The general development of skin melanin during treatment or exposure is suggestive, since melanins could very easily be the precursors of carcinogenic aromatic hydrocarbons.

498. Landahl, H.D. and Black, S.: Penetration of air-borne particulates through the human nose. J. Ind. Hyg. Toxicol. 29:269-77, 1947.
The role of particle diameter and air flow rate in the penetration of particulate material passing through the human nose was investigated using dispersed corn oil aerosol and $NaHCO_3$ and $Ca_3(PO_4)_2$ dusts. The apparatus for generating, exposing and collecting the materials is described in detail. Samples of both influent and effluent air streams were collected by impingement on microscope slides placed in each of the steps of the cascade impactors and in the impinger and filter which made possible the separation of the material into relatively homogeneous size groups. Exposures were made on 4-6 human subjects and lasted 1/2 min. The results are tabulated and graphed in detail and show that at 10, 17, 29 and 60 l./min. the particle diameters corresponding to 50% penetration were found to be 8, 5, 5 and 2 μ, respectively, for corn oil; at 17 and 60 l./min. the diameters for 50% penetration were 2 and 1 μ for $NaHCO_3$ and at 17 l./min. for $Ca_3(PO_4)_2$, the 50% penetration size was 4 μ. The last was heavily aggregated, but only particles appearing to be unitary were counted. The greater penetration of corn oil droplets over $NaHCO_3$ particles is thought to be largely due to their lower density, although the hygroscopic nature of the latter and also the shape factor must be important. With the $Ca_3(PO_4)_2$ particles the effect of the density of the material is offset by the fact that the particles are aggregates of small units.

499. Laskin, S., Turner, R.A. and Stokinger, H.E.: Analysis of dust and fume hazards in a beryllium plant. U.S. Atomic Energy Comm. Doc. MDDC - 1355, Decl. Sept. 25, 1947.
In a Be-producing plant, investigated because of frequent occurrence of Be poisoning, the following major potential hazards were present: Be ore dusts, BeO, BeCu acid mists and fumes ($BeSO_4$), Pb and Cu sulfides, SO_3, acid fluoride, $(NH_4)_2BeF_4$, BeF_2HF, NH_4Fdusts and fumes and Be metal. Selected areas of atmospheric contamination associated with the processes

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involved were sampled, the selection being based on past medical history of hazard or on obvious contamination at the time of the survey. Sites selected were the ore-treatment area and that about the BeF$_2$ and Be metal furnaces. Of the 3 areas surveyed, those of the BeF$_2$ and Be metal furnaces showed the most hazardous concentrations of Be and F. The F concentration near the F furnace was disproportionately high, possibly representing a hazard in itself. The concentration of Be 3 ft. from the furnace opening during the pouring operation was ca. 0.065 mg./m.^{3}. During the pouring operation of the Be metal furnace, Be concentrations varied from 1.4 to 4.7 mg./m.^{3} at approximately 3 ft. from the furnace. Samples for F in this site were of the order of 1.7 mg./m.^{3}. Near the rotary kiln drier for Be ore treatment, Be dust concentration varied from 0.050 to 0.53 mg./m.^{3}. F concentrations in the air were of the same order of magnitude. A particle-size analysis of the air contamination samples by the means of the cascade impactor showed a mass median particle size of 0.86μ in the vicinity of the Be metal furnace, 2.46μ next to the BeF$_2$ furnace, but sizes of up to 10μ in the area about the ore treatment room. Another problem investigated was that of beryl ores suspected of containing radioactive impurities. One of 3 suspected ores showed significant β activity equivalent to 12.6% U, which on spectrochemical analysis later revealed 4% U, 0.4% Th and 0.4% Pb. This degree of activity represents a definite Tn or Rd hazard and suggests the possibility that U or other radioactive materials may act synergistically or as predisposing agents in Be poisoning. During the period 1943-6, 136 cases of Be poisoning were observed, most of which involved conditions of the skin (50%) and the respiratory tract. The latter were attributed to all exposures present, while dermatologic symptoms resulted from exposure to BeSO$_4$ and BeO, Be fluorides and SO$_3$. The affected workers ranged in age from 20 to 50 yr. 117 of them were male, 19 female. The onset of the acute respiratory symptoms was observed 1-4 mo. after the first exposure, occasionally even after 3-10 da.; the dermatologic conditions appeared after 7-10, occasionally after 2 da. The dermatitis, affecting exposed areas of the skin, was often severe, being of the edematous, papulovesicular type. When the face was involved, there was invariably associated conjunctivitis. An element of sensitivity was believed demonstrated. It was not uncommon to find individuals showing both dermatitis and bronchitis, especially if permitted to continue work in the areas of the sulfating process and F furnace. Chemical pneumonitis presented the severest type of Be poisoning and occurred among workers without respect to type of process. Several deaths from this cause were reported in 1943. Typical symptoms were cough, substernal pain, shortness of breath, cyanosis, anorexia, weight loss and increasing fatigue. The vital capacity was reduced. There was a low-grade fever. Recovery did not occur if work was continued. Examination of lung tissue sections showed a large number of plasma cells, diffuse pulmonary edema and hemorrhage. X-rays of the lungs were diagnostic. Prior to 1943, the plant had experienced relatively little trouble, but increase in intensity of operations with the outbreak of war, together with loss of trained and selected personnel by the operation of the draft, may be listed as possible factors responsible for an epidemic effect.

The general plant history showed a shift in the number of cases through the years 1943 to 1946. During 1943-4, the sulfate and Be-Cu processes were particularly involved. Following improved conditions at this site, the production emphasis shifted to BeF$_2$ and Be metal where, at the time of investigation, the greatest proportion of cases appears (1946). The number of cases ranged from 63.5 to 238.1/million man-hr. of exposure, whereas the acceptable number in well-established chemical industries is 4.

500. Roth, H.P. and Swenson, E.A.: Physiological studies of irritant aspects of atmospheric pollution. Office of Air Pollution Control and University of Southern California, School of Medicine, Los Angeles, 1947.

The study was made to determine threshold levels for eye irritation from formaldehyde. Some persons were sensitive to concentrations as low as 0.25 ppm, while others did not experience irritation until concentrations of 5-10 ppm were reached. Older persons were more sensitive than younger ones. Increased humidity raised the threshold for irritation. (Abst. Heimann, H. et al., U.S. Public Health Service, 1950.)

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501. Williams, C.R.: Significant aspects of exposure to beryllium compounds in industry. Occupational Med. 4:104-10, 1947.

There are apparently 2 forms of reaction to exposure to Be in industry. The 1st is the acute form of chemical pneumonitis. This has resulted from exposure to high concentrations of Be compounds including fluoride, oxyfluoride and oxide. There appears to be a definite relation between exposure and development of cases, and in addition, symptoms clear up when exposure is eliminated. The 2nd form is a delayed chronic pulmonary reaction resulting from exposure to small amounts of Be compounds in air. This disease is characterized by a delay of from 1 mo.-5 yr. between exposure and onset, pronounced shortness of breath and loss of weight, as well as characteristic roentgenograms. In addition, during the period of delay patients have normal roentgenograms of the chest, and finally, may show typical roentgen changes prior to development of symptoms. There is a low incidence rate of this type among large numbers of employees, e.g., 31 cases among 600 employees in 1 plant. There is no apparent relation between severity of exposure and development of cases. It is thought possible, by Gardner, "that this apparent lack of correlation between susceptibility and the degree of atmospheric contamination, together with the spotty distribution of the disease and its complete absence from some plants using Be, suggest that Be alone does not produce the disease but that it acts in combination with some other factor to initiate this pathological process." The amounts of Be in pulmonary ash in 16 autopsies (4 acute, 12 chronic) is low, ranging from traces-0.54%. There are many unknown factors. The fate of Be in the body and the mechanism by which it may produce pulmonary damage are not understood. There is no available adequate method of analysis for Be in air, tissue or body fluids. A spectrographic method has been developed but not described in the literature. There are few data as to atmospheric concentrations of Be or its compounds in plants where cases have developed, partly because of having no method of analysis available and partly because of the delay in onset. Reproduction of this disease in animals has not yet been possible.

502. Zelenetskii, M.I.: (A case of sulfur dioxide poisoning in the canning industry.) Gigiena i. Sanit. 12, No.10:45-6, 1947.

The evolution of SO_2 in a pit in which 30 tons of sulfite-treated pear mash had been stored for several mo. caused 3 deaths in the course of emptying the pit. Analysis showed the SO_2 content of the air in the pit to be 0.16%. The presence of SO_2 was not noticeable by odor, but small bubbles in the pear mash indicated fermentation processes. The analysis of air samples, taken in the pit at 0.5, 1.0, 1.5, 2.0 and 2.5 m. distance from the upper rim, gave the following results: 34% CO_2, 2-5% O_2, SO_2 at concentrations between 0.002 and 0.005 mg./l. air were present. The incident demonstrated the importance of analyzing air samples for all gases present, rather than just for that of SO_2.

503. Agate, J.N.: Delayed pneumonitis in a beryllium worker. Report of a case. Lancet II:530-3, 1948.

A physicist engaged in laboratory research developed a chronic pneumonitis 3 yr. after approximately a 1-yr. exposure to a phosphorescent powder (Zn-Be-Mn-silicate) used in making fluorescent lamps. The patient inadvertently exposed himself to risk, for it is not generally understood that the degree of exposure needed for this dust to cause harm is much less than that usually needed to bring about occupational pulmonary disease. Cough, dyspnea and extreme loss of weight were the chief clinical features. Radiography revealed extensive bilateral pulmonary disease. Granulomatous lesions were found in the liver without biochemical evidence of liver disorder. Further cases may be expected in Great Britain due to a considerable expansion of the commercial use of Be. If the onset of the disease can be delayed as long as 6 yr. the etiology may not be suspected without an adequate history of the patient's occupation. Where possible, substitution of other compounds for Be is the best preventive measure. In processes where this element must be used, vigorous suppression of dust and fumes and regular medical supervision of workers are necessary. The prognosis of the disease is poor, treatment is ineffectual and the disability may be serious and permanent. Legislation for compensation is advised. (Condensed author's summary.)

504. Dautrebande, L., Alford, W.C., Highman, B., Downing, R. and Weaver, F.L.: Studies on aerosols. V. Effect of dust and pneumodilating aerosols on lung volume and type of respiration in man. J. Appl. Physiol. 1:339-49, 1948.

The effect of inhaled dust on respiration using the following dusts of 0.7μ in mean size: powdered Al at 6.6 mg./inspiration; Al hydrate, 7.0 mg.; willemite, 3.5 mg.; dolomite, 6.0 mg.; calschist, 5.5 mg.; Cu sulfide, 3.0 mg. and Zn sulfide, 2.8 mg., was determined on 3 healthy subjects alone, before and after administration of a pneumodilating aerosol of 1 of the following aqueous solutions: 0.2% aleudrin; 0.1% aleudrin and 0.25% neosynephrine; and 0.1-0.2% procaine and 0.5-1.0% tincture of lobelia, which is powerful with no detectable systemic effects. The order of exposure included a pre-exposure period for 2-5 min. and then exposure to the following for 2 min. each: dust, normal air, aerosol, normal air, dust, normal air, aerosol, normal air, dust, etc., or other desired variations. Inhalation of small quantities of fine dust of supposedly therapeutic dusts, e.g., Al, as well as siliceous material produced no subjective irritation but induced a rapid shallow type of respiration and a marked reduction in pulmonary volume. The magnitude of the volume change suggested that not only the bronchi but also the alveolar ducts were involved in the constriction. This condition did not disappear immediately when the subjects returned to normal air. Repeated exposures to dust, interrupted by short intervals of normal air doses, intensified pneumoconstriction and more frequent respiration. A few inspirations of aqueous aerosols of active pneumodilating drugs brought the lung volume back to, or above, normal after inhalation of dust. Simultaneously, the subject's respiration became slow and deep, which slowly returned to normal upon again inhaling normal air. In no case observed was there a return to the constricted state. Immediately after a pneumodilation of the lungs by aerosols, inhalation of dusts caused little or no pneumoconstriction or any rapid shallow respiration. After 2 or 3 successive dilations, there was no constriction when the subject inhaled the quantity of dust used in these experiments. It is suggested that treatment of a pneumodilating aerosol before inhalation in Al therapy might enhance its effects. Also, studies to investigate pneumodilating aerosol therapy for workmen exposed to dusty atmospheres should be undertaken.

505. Dutra, F.R.: The pneumonitis and granulomatosis peculiar to beryllium workers. Am. J. Pathol. 24:1137-52, 1948.

This report is compiled from a study of the tissues from 7 persons who died of acute pneumonitis and from 13 persons who died of chronic granulomatosis. The pulmonary lesions in these 2 clinical conditions are specific and there is evidence of transition of the pathologic lesions of the acute condition to those of the chronic one. In the acute pneumonitis there is a boggy, generalized consolidation of lobes, simulating to some extent the stage of gray hepatization in lobar pneumonia. Microscopically there is diffuse intra-alveolar exudate composed of large mononuclear phagocytes (septal cells) and edema fluid. Intraseptal lymphocytes and plasma cells are also fairly numerous. In 1 case centrolobular necrosis of the liver was seen. With chronic pulmonary fibrosis (granulomatosis), the lungs were voluminous and emphysematous. Scattered diffusely throughout the lungs were fine nodules. Enlargement of the right ventricle of the heart was constantly present in these cases. Microscopic characteristics include diffuse interstitial and nodular fibrosis of the lungs together with a peculiar granulomatous reaction. The granulomas which are typical of Be disease are formed in part within alveolar spaces by the organization of exudate, and in part within the septal and peritruncal connective tissues. They are comprised of central regions of fibrinoid material or granular debris, and the central regions are surrounded by a peripheral zone of fibrosis in which there is an infiltration of lymphocytes and plasma cells. The centers of the granulomas are occasionally occupied by giant cells of the Langhans' type. There are conchoidal bodies in most cases, sometimes within giant cells, sometimes lying free in debris or in fibrous tissue.

506. Eisenbud, M., Berghout, C.F. and Steadman, L.T.: Environmental studies in plants and laboratories using beryllium. The acute disease. J. Ind. Hyg. Toxicol. 30:281-5, 1948.

Several hundred air samples were collected on filter paper and analyzed spectrographically. The compounds studied were Be sulfate, oxide, fluoride, hydroxide, metallic dust and beryl. Those definitely shown to cause acute pneumonitis are: the sulfate, fluoride, oxide and metallic dust. (The hydroxide is thought to be capable of producing the acute disease due to its similarity to the oxide; this was not demonstrated conclusively because no workers were found who had been exposed exclusively to the hydroxide.) Beryl was found to demonstrate no acute toxicity. At typical operations in a Be plant concentrations of 0.85 mg. Be in $BeSO_4$/day, 0.54 and 0.55 mg. Be in BeF_2/day and 4.0 mg. Be in BeO/day gave a high frequency of acute cases; 1.3 mg. Be in BeF_2/day gave a moderate frequency; 1.0 mg. metallic Be/day, a low frequency and 13 mg. Be in beryl ore/day and 300 mg. Be in BeO/day gave no report of acute cases. From this it is seen that the toxicity of the oxide is extremely variable, depending on a number of factors such as particle size, surface area and temperature of processing. Many acute cases have resulted from a single excessive exposure. In the case of the fluoride, an exposure of 20 min. duration is known to have produced 3 cases of acute pneumonitis. The fume concentration determined from the air samples approximated the calculated maximum fume concentration of ca. 5 mg./m.^{3} and the total quantity of Be inhaled during the exposure period was on the order of 45 µg.

507. Friberg, L.: Proteinuria and kidney damage among workmen exposed to cadmium and nickel dust. J. Ind. Hyg. Toxicol. 30:32-6, 1948.

Workmen employed in the manufacture of alkali storage batteries complained of increased fatigue which prompted an investigation of a possible

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Friberg, L. (continued)
industrial health hazard. In the production of the battery electrodes which contain hydrate of Ni and Cd oxide a fine metallic dust is formed. Air analysis of a typical atmosphere indicated values of 0.003-0.9 mg. Cd and 0.01-0.7 mg. Ni/l. air. In addition a small admixture of Fe and graphite was included in the dust. A preliminary medical investigation was started which included 38 employees. They were divided into 2 groups. Group I was made up of 19 men who had worked in the factory less than 3 yr. (average, 1 yr.). The majority were 20-30 yr. of age. Group II included 19 men, 29-59 yr. of age with a length of service exceeding 8 yr. The complaints of the workers within both groups differed. The most frequently occurring symptoms were fatigue, nervousness and irritability, increased thirst and parched mouth, cough and shortness of breath. As a rule the difficulties were more pronounced and occurred among a greater number of the workmen with the longest service. Group I had no loss of smell, but 12 out of 19 in Group II suffered from loss of smell. In Group I there were no pathologic changes among the men which could be determined as having possible connection with their work. None had proteinuria. In Group II proteinuria was certified among 18 of the workers, but with no certain etiology. The case histories revealed that some of them had been treated by various doctors during a number of years for chronic inflammation of the kidneys. At least 3 components were found in the protein. In 14 cases, impaired kidney function was observed. The bloods of 8 workers with proteinuria were examined polarographically and pathogenic changes were found in all cases. The author states that these changes implied that a low molecular weight protein was possible which was not found among healthy persons. A search by the author and a discussion presented in the text shows similar pathologic changes have not hitherto been reported in the literature. A supplement is added to the article in which further work brought to light lung impairment (emphysema) in 15 of the 17 cases examined. These changes were noticeable through X-ray only in 4 cases. 6 patients showed in their X-ray examinations signs of inactive pulmonary t.b. and 1 had active t.b.

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508. Hatch, T. and Hemeon, W.C.L.: Influence of particle size in dust exposure. J. Ind. Hyg. Toxicol. 30:172-80, 1948.
The influence of particle size on alveolar dust deposition and retention, and on the toxicity of dusts is reviewed and relatively quantitative equations are developed to point out this significant influence. The effect of flocculation of dust in dust hazards is also discussed and an indirect method of sampling dust flocculation, by the use of the spiral, is described.

509. Hill, A.B. and Faning, E.L.: Studies in the incidence of cancer in a factory handling inorganic compounds of arsenic. I. Mortality experience in the factory. Brit. J. Ind. Med. 5:2-6, 1948.
The following investigation was undertaken to demonstrate association between As and carcinogenesis. Proportional mortality figures for factory and other workers for 1910-43 were compared. Without regard to age or period of time of death 22 of the 75 deaths of factory workers (29.3%) were from cancer, while 157 of 1,216 deaths of other workers (12.9%) were from this cause. According to occupations 14% of the agricultural laborers' deaths, 14% of the general laborers' and 12% of the artisans' or shopworkers' were from cancer. Finer comparisons were made. When these rates are analyzed according to periods of yr. in which they were certified, viz.,

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Hill, A.B. et al. (continued)
1910-9, 1920-9 and 1930-43, tests of significance for each period give $P=0.12$, 0.11 and 0.0009, respectively, and $P<0.01$ for the total. According to age groups, viz., <55, 55-69 and 70+, tests of significance were $P=0.027$, 0.0009 and 0.99, respectively, and $P<0.01$ for the total. The deaths of all causes of the factory workers listed by period and age were compared with the numbers that would be "expected" to be due to cancer and other causes on the basis of the proportions shown by the other occupational groups. From this 11 deaths (14.7%) of the factory workers would have been expected rather than the registered 22. A comparison of the records of factory workers who would not be exposed to any specific hazards, viz., builders, printers, box-makers, etc., with those of the chemical workers, engineers and packers in the factory, shows a much greater cancer death rate among the latter group. Only 12.5% of the deaths of the former group were due to cancer, while 39% of the deaths of chemical workers and 33.3% of the engineers and packers were due to cancer. Analysis of cancer deaths by site, though based on too little material, suggests a relative excess in the factory workers of cancers of the respiratory system and skin and a corresponding deficit in the digestive organs and peritoneum. Of the 22 deaths, 5 were from cancer of the lung, 2 from other respiratory sites, 3 from cancer of the skin and 12 from other sites.

510. Landahl, H.D. and Herrmann, R.G.: On the retention of air-borne particulates in human lung. J. Ind. Hyg. Toxicol. 30:181-8, 1948.

The experimental procedure for the measurement on human subjects of lung retention of air-borne particulates is described and a diagram of the apparatus used is given. Samples of inhaled and exhaled air are collected on slides in various size fractions (cascade impactor), and the mean mass diameter (MMD) of a given fraction is plotted against the % retention of the whole. The variable factors, density, hygroscopicity, shape of particle, inspiration rate, tidal air and mean time in the lung, are considered.

The data suggest that there is a particle diameter giving minimum retention,particles both larger and smaller than this being retained more readily. For a fixed breathing pattern, impaction and settling, and thus retention (R), depend on density (ρ), as well as upon diameter (d); $R=\rho d^2$. With an increase in humidity, there is an increase in particle size with hygroscopic materials. Increasing the tidal air or decreasing the frequency of respiration (giving an increased mean time), at a constant inspiratory flow rate, markedly increases retention. Increasing the inspiratory flow rate for a constant breathing pattern increases retention or decreases particle size at a given retention (50% retention of $NaHCO_3$ at 18 l./min. and 60 l./min. gives particle diameters of 0.8 and 0.3 μ, respectively). The following values were found for the particle diameters corresponding to the 50% retention (MMD of the whole) for the various materials used with the same breathing pattern (18 l./min., 15 respirations/min. and 450 cc. tidal air): corn oil, 3μ; $NaHCO_3$(dust), 0.9; $NaHCO_3$(dispersed from solution but dry), 0.8; $Ca_3(PO_4)_2$, 1.5; glycerol, 0.7 and methylene blue, 1.2μ. In some cases (corn oil, $NaHCO_3$ from solution and $Ca_3(PO_4)_2$), the lung retention curves were compared with the nose retention curves from a previous paper (Ibid. 29:269-77, 1947) and the curves for lung retention with mouth breathing and nasal retention on expiration were calculated.

511. Machle, W., Beyer, E. and Gregorius, F.: Berylliosis. Occupational Med. 5:671-83, 1948.

Injuries caused by Be compounds have not been reported from mining, handling and shipping of beryl but from processing Be from beryl. So far,

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Machle, W. et al. (continued)
about 400 cases of berylliosis have been recorded, the rates of attack being usually related with magnitude of exposure and type of compound, such as Be metal (with oxide coating), BeO, BeF$_2$, Be sulfate, lamp phosphors and Be(OH)$_2$. The MAC has not yet been established, but exposure to 100 μg. BeO/m.^{3} of air has caused berylliosis, while that to 2-8 μg. Be/m.^{3} as lamp phosphor, for 6 yr., was without effect. The more soluble compounds tend to cause acute berylliosis, while the less soluble may have chronic effects. Berylliosis occurs independent of race, sex or age. There is very little or no absorption of Be by the gastroenteric tract. The presence of Be in the urine indicates previous exposure. Be compounds, taken up by inhalation, remain in the lungs for up to several yr. The exposure to Be compounds may result in acute, inflammatory, exudative and proliferate reactions, similar to other forms of acute chemical pneumonitis except for the absence of necrosis and pronounced polymorphonuclear leukocytic infiltration. It may also cause chronic granulomata in the lungs, skin, subcutaneous tissue and both hilar and axillary lymph nodes, as well as in the liver. Further symptoms mentioned are: conjunctivitis, acute irritation of the upper respiratory tract and dermatitis. The differentiation between acute and chronic berylliosis is difficult, since an acute attack may be followed by chronic berylliosis. The typical symptoms observed in these conditions are discussed in detail, as cough, occasionally with blood-streaked sputum, exertional dyspnea, weight loss, asthenia, further the characteristic diffuse, nodular roentgenographic pattern, as well as, in chronic cases, the delayed onset, frequently up to several years after the termination of exposure. The fatality rate ranges from 10 to 26%. Supportive treatment and prophylactic measures are suggested.

512. Pascucci, L.M.: Pulmonary disease in workers exposed to beryllium compounds: its roentgen characteristics. Radiology 50:23-36, 1948.

An examination of chest films of 32 people exposed to Be compounds in their occupations was made. The patients were preponderantly females in accord with the plant ratio, were aged 21-43, average 29, and had an average duration of 16 mo. exposure. Symptoms appeared, or the 1st positive X-ray evidence was discovered, 24 mo. (average) following change of job or cessation of the supposedly hazardous operation. Dyspnea, cough and weight loss were the most frequent symptoms; fatigue, lassitude, anorexia and low-grade fever were also occasionally present. The physical findings showed impaired resonance of the chest and fine rales throughout the lungs. In the 32 cases studied, the clinical course varied. About 30% died, 30% were unimproved or slightly worse and 40% were improved. The X-ray findings were characterized by a bilateral, uniformly widespread, diffusely granular and/or nodular infiltration. No definite disease entity is known which can produce the fine, disseminated granular type of infiltration observed in these cases. In both types, but more so in the granular, there may develop coalescent or confluent shadows. Correlation between the clinical course of the disease and the magnitude of the pulmonary changes was not possible because of the inadequate period of observation.

513. Perry, K., Bowler, R.G., Buckell, H.M., Druett, H.A. and Schilling, R.S.F.: Studies in the incidence of cancer in a factory handling inorganic compounds of arsenic. II. Clinical and environmental investigations. Brit. J. Ind. Med. 5:6-15, 1948.

A clinical and environmental investigation was carried out in a factory handling inorganic As compounds. The processes of preparation and packing

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Perry, K. et al. (continued)
of an arsenical powder are described. Atmospheric dust samples in the various workrooms were taken using a cascade impactor. Size distribution was estimated both by microscopic counts and by chemical estimation of the amount of aerosol deposited on the 4 impactor plates. The chemical method showed a higher % of the arsenical cloud (36-70%) in the most respirable size range, given as 10/μ-15/μ, than did the microscopic counts (5-20% at 10/μ-15/μ and 100% at 60/μ-80/μ). The mean and the median values of the As content in the atmospheres over the various operations are given as: dryer - 384 μg. As/m.^{3} and 254 μg. As/m.^{3}, respectively, kibbler - 1,034 and 696, sieving - 422 and 373 and packing - 78 and 71. The clinical examination included clinical and occupational histories, a full physical examination with special attention paid to pigmentation, numbers of warts and perforation of the nasal septum, X-ray examination of the chest, measure of the vital capacity and an exercise-tolerance test. Hair and urine were analyzed for As. A mean of 24.3 mg. As/100 ml. urine was found for the 58 chemical workers examined, 10.1 for the 32 maintenance workers, 10.7 for the 22 packers and 9.2 for the 54 controls. The ppm As in hair for these same groups of workers were 108, 85, 64 and 13, respectively. The 1st 3 groups, and especially the chemical workers, were exposed to As in the plant while the controls were at the plant but were not exposed. Clinically the workers manifested gross pigmentation, with hyperkeratinization of exposed parts with a tendency to wart formation. The maintenance workers and packers occupied an intermediate position, while a few of the controls showed slight pigmentation and a single wart in 2 cases only. "No worker was found who had carcinoma of the bronchus, but since the trachea and bronchi must be exposed to the same dust as the skin, and since they are lined by a modified squamous epithelium, it is only natural to expect that they would undergo the same changes. After many years' exposure a squamous-cell carcinoma may develop in the bronchus. Two cases were seen in which warts had become malignant and had been treated with Ra." It is concluded, then, that while no concrete evidence was found to confirm the statistical findings of the mortality investigation (Hill, A.B. and Faning, E.L.: Ibid. 5:2-6, 1948), there was circumstantial evidence to support these findings in the form of clinical observations of skin changes in all the As workers.

514. Titus, A.C.: Air contamination during machining of beryllium stainless steel. J. Ind. Hyg. Toxicol. 30:29-31, 1948.
Exposures to Be during sawing, machining and grinding Turballoy No. 4 which contains .7% Be were investigated. In the particle stream during grinding the exposure was 366 γ/day. With a local exhaust on the grinder, the exposure was 0.02-0.17 γ/day. The exposure for the other operations was 0.12-0.6 γ/day. No Be poisoning cases were reported.

515. Wilson, I.B. and LaMer, V.K.: The retention of aerosol particles in the human respiratory tract as a function of particle radius. J. Ind. Hyg. Toxicol. 30:265-80, 1948.
Highly homogeneous (or monodispersed) aerosols were inhaled at various breathing rates by 7 subjects. The aerosol particles consisted of droplets of equal volumes of H_2O and glycerol condensed, in varying sizes, on NaCl nuclei (ca.0.06μ) containing a trace of Na^{24} (0.8 μc./l. aerosol). The preparation of these aerosols is described in great detail. Exhaled aerosol was collected on a filter so over-all retention could be determined. After a 5-min. inhalation, a cylindrical Geiger-Mueller counter was placed horizontally against the chest wall in the axillary region and

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Wilson, I.B. et al. (continued)

the γ-ray (β-ray absorbed) impulses counted (described in detail) for 4 min. starting 1/2 min. after cessation of inhalation, thus measuring the alveolar retention. Blood samples from the arm were collected 15 min. after the end of inhalation and also measured for Na^{24}. This procedure was repeated several times for each subject using a different particle size (duplicate experiment run on each size). Total retentions, lower respiratory retention and blood levels were determined as functions of the particle size and of the breathing rate. Particle size was measured by means of the higher order Tyndall spectra calibrated in terms of sedimentation rate for radii 0.15-1.0 μ. For sizes $>1.0\mu$, the radius was determined by microscopic measurement (easier, less accurate), or from the velocity of sedimentation. The data for breathing rates of 5.5 - 20 cycles/min. are tabulated and include radius, μc. Na^{24} inhaled, % total retention, axillary count (count/min./μc. inhaled), and blood concentration μc. Na^{24}/μc. Na^{24} inhaled X 10^{6}. The total retentions (P) (plotted on log-log paper against r) below 85%, follow the equation $P=Qr^{n}$ (r-radius, Q & n-functions of the breathing rate-R), and the retention decreases linearly with increasing breathing rate (R) according to the empirical equation: $P = 105r^{0.163} - (0.237 - 0.029)R$. The alveolar retention, when plotted as axillary count against r (in μ), exhibits a maximum with 2 peaks in the range 0.3-1.0 μ. This maximum corresponds to about 55% of the inhaled aerosol. Considerations of the Na^{24} count in the blood and a probable 75% loss of Na^{24} from the blood by diffusion to the extracellular fluids indicate alveolar retentions ranging from 31-63% of the inhaled aerosol.

516. Aub, J.C. and Grier, R.S.: Acute pneumonitis in workers exposed to beryllium oxide and beryllium metal. J. Ind. Hyg. Toxicol. 31:123-33, 1949.

Seven cases are reported of acute pneumonitis in workers exposed to dusts and fumes of pure Be metal and BeO. The average duration of exposure was ca. 3 mo., except for 1 of 3 yr. The symptoms usually had their onset within 2.5 mo. after beginning work with Be. The symptoms included exertional dyspnea, fatigue and lassitude, pain in the chest, cough, weight loss, vague gastrointestinal symptoms and fever. The X-ray changes in these cases were of a transient nature and less well developed than those seen in pulmonary granulomatosis. The findings ranged from increased perihilar shadows with diminished radiance of the lung fields to extensive granular infiltration which was suggestive to the radiologists of an acute silicosis or sarcoidosis or resembled the lesions seen from the fluorescent lamp industry. Except for 2 cases the symptomatology and clinical courses were mild and the patients were ambulatory throughout, and 3 of the patients continued to work throughout their illness as the nature of their disease was recognized at the time. The other 2 were quite ill, requiring hospitalization and were away from work for 7 in 1 case and 15 wk. in the other. Each of the 7 case histories are reported in detail. The cases are considered interesting because they represented the 1st examples of the occurrence of this reaction following exposure to only the oxide and the metal, in contrast to other reported cases where the soluble salts of Be were also present. These cases tend to support the view that the Be ion is toxic in its own right, rather than attributing the disease associated with soluble Be salts to the acid radicals.

517. Bartak, F. and Tomecka, M.: Stannosis (Coniosis due to tin.) Proc. 9th Intern. Congr. Ind. Med., London 1948:744-54, 1949.

The authors have shown that pneumoconiosis can result from exposure to SnO$_2$ dust in air. The case of a man, aged 49, is recorded. He worked

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Bartak, F. et al. (continued)
18 yr. in an enamel factory in which Sn was burned to SnO_2. He suffered from asthma. X-rays of his lungs showed many fine dark grains. These were diagnosed as SnO_2 particles in the lungs. The man died a few years later of stomach cancer. His tissue was analyzed for SnO_2. The largest amount of 0.5907 g./2.90 g. ashed tissue was found in the lungs. Spleen and liver contained only a small amount. 16 other workers in the enamel plant were X-rayed. 6 of them showed signs of stannosis. These men had been exposed to the dust from 6 mo. to 25 yr. The authors consider typical signs of stannosis are: X-ray findings, euphoric state even of those suffering intensely, macrophage reactions in the lungs and the slow transport of the SnO_2 particles from the place of primary infection. The presence of the oxide in the liver and spleen may be due to penetration from the gastrointestinal tract. Guinea pigs and rabbits were used as a type of control for the X-rays and chemical examinations of the workers. The animals were given injections of SnO_2 intravenously, intracardially, subcutaneously and intra-abdominally. The X-ray pictures as well as the microscopical pictures were like the pictures of the deceased man. 12 X-ray and histological pictures are reproduced in the article.

The authors cite as evidence for the existence of stannosis in the enamel workers: 1. The persons examined were exposed to the dust of SnO_2. 2. X-ray pictures of the lungs were typical. 3. Chemical quantitative and qualitative proof of tin oxide in the organs of the deceased worker. 4. Spectrographic proof of SnO_2 in the lungs and in the lymph nodes. 5. Histological proof of the metal in the lungs and the lymph nodes. 6. Comparative experiments with animals and human subjects. It seems stannosis, as far as is known, is a special type of coniosis, clinically as well as physiologically and pathologically. The relatively small amounts of SnO_2 found in the lymph nodules may be accounted for by a slow phagocytosis and transportation.

✓ 518. Davies, C.N.: Inhalation risk and particle size in dust and mist. Brit. J. Ind. Med. 6:245-53, 1949.

This is a review of the literature on the subject. In the discussion of respiratory absorption and elimination, it is pointed out that particles deposited in the trachea, bronchi or bronchioles are normally removed by ciliary action; this will not prevent absorption of water-soluble material and may fail through impairment of the ciliated epithelium or the mucus coating due to illness or chemical action. The ciliary mechanism is ineffective for liquids. Elimination from the alveoli is by phagocytes. Although particle size is decisive in governing the region of initial deposition in the respiratory tract, only in certain cases is it possible to claim immunity from health risk on this basis. Also discussed are the experiments on inhalation and retention of dusts, the effect of particle size and nasal filtration. For abstracts of the original articles, see Brown et al., Drinker et al., Hatch et al., Landahl et al., Tourangeau and Drinker, van Wijk and Patterson and Wilson and LaMer.

519. DeNardi, J.M., Van Ordstrand, H.S. and Carmody, M.G.: Acute dermatitis in beryllium workers. Review of 406 cases in eight-year period with follow-up on recoveries. Ohio State Med. J. 45:567-75, 1949.

The disease entity with acute dermal and respiratory manifestations occurring in workers in plants producing Be and its compounds still contains many unknown factors as to the etiology. There is sufficient evidence, however, for the influence of host hypersensitivity on its

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DeNardi, J.M. et al. (continued)
development and course. From 1940 through 1948, 406 cases were encountered in 3 plants in the Cleveland area. Of these, 195 patients had dermatitis, including 134 with definite contact and host hypersensitivity, 59 had effects of direct contact and 2 were unclassified cases. In the other 211, major respiratory tract processes predominated: tracheobronchitis in 121 and pneumonitis in 90, both preceded by chemical nasopharyngitis. Apart from the 2 forms of dermatitis mentioned above, which affect >25% of the new employees exposed to fumes and dusts of the various Be salts, the following conditions can result within 3-10 da.: urticarial and hyperemic, discrete papular or papulovesicular lesions, all of which cause burning and pruritus, as well as Be ulcer, developing due the penetration of minute crystals of Be fluoride, Be sulfate and Be tetrahydrate into injured skin. In chronic form it can be effectively treated only by curettage. The hypersensitive dermatologic response to Be is considered a rough indicator of individual susceptibility to respiratory tract manifestations. Of the reported 90 cases of pneumonitis 10 resulted in death, although not due to the latter but coincidentally. 2 main types of pneumonitis can be distinguished: a) the rare fulminating type, developing <72 hr. after exposure and regressing within 7 to 16 da., is characterized by spasmodic cough, dyspnea and substernal pain, feeling of congestion due to limited thorax expansion, reduction of the vital capacity, rales and acrocyanosis. b) The more frequent insidious type, occurring due to cumulative exposure, the duration averaging 4-12 wk., shows the same symptoms in aggravated form, weight loss, weakness, more extensive rales and increased pulse and respiratory rates. Usually, the laboratory findings and the body temperature are normal. Roentgenologically, 1-3 wk. after the appearance of the symptoms in both types of the acute disease, lung changes range from haziness and punctate infiltrations to consolidation resembling malignant metastases. Unless re-exposure occurs, cases of acute Be pneumonitis do not reoccur, nor are there any sequelae after recovery.

For 2 of the 3 plants mentioned above, the total annual (for 1940-'48) incidence of dermal and respiratory diseases, the probably causative agents and the resulting time losses are tabulated. 20 case and follow-up reports, concerning 17 males (age 21-65 yr.) and 3 females (age 19-39 yr.) confirm the above observations.

520. Donald, K.W. and Christie, R.V.: The respiratory response to carbon dioxide and anoxia in emphysema. Clin. Sci. 8:33-44, 1949.

The reaction to 4% CO_2 of 28 normal, 23 emphysematous and 7 asthmatic subjects has been studied. Of 23 emphysematous patients, 16 gave impaired reactions in the 1st 5 min. of exposure. The 7 asthmatic subjects gave normal reactions. The reaction of the CO_2 tolerant cases to anoxia and to longer exposures to 4% CO_2 has been investigated. The causes of the impaired reaction to CO_2 in emphysema and its diagnostic significance are discussed in relation to these findings. (Author's summary.)

521. Dunner, L., Hardy, R. and Bagnall, D.J.T.: Pneumoconiosis after exposure to sulfur dioxide fumes and dust from coke fires. Lancet 2:1214-6, 1949.

The first case observed was a man with radiological evidence of basal pulmonary fibrosis and bronchiectasis. Questioning revealed that he had been a "boiler-stoker" for 33 yr., and that during his work in a confined space he inhaled "S" fumes and quantities of dust, both originating from burning coke. 10 other cases of this pathological state were noted in workers who had been exposed to irritant "S" fumes and dust arising from coke fires in such trades as boiler stokers, blacksmiths, platers and

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Dunner, L. et al., (continued)
coke-oven and gas-works employees. Gas-workers, in general, however, were less exposed. The radiological appearances were those of irregular patchy fibrosis involving both lungs but usually predominant in one. The mid and lower zones showed nodulation which had occasionally produced, by confluence, patchy consolidation. Radiological evidence of emphysema was usually present, the radiotranslucent emphysematous zones being in sharp contrast with the adjacent areas of dense fibrosis. In differential diagnosis, t.b. was excluded with certainty. Pulmonary syphilis and Boeck's sarcoidosis were carefully considered and finally ruled out. In none of the workers was there any history of other risk to dust or fume inhalation, or of previous major illness. A sample of coke-flue dust was collected and analyzed. The dust had the appearance of burnt ash from coal; the fine fraction had a particle size of about 2μ and contained 34% of total SiO_2, 2.6% of free SiO_2 and 17.5% of Fe compounds expressed as Fe_2O_3. It is tentatively concluded that the series of cases exhibits occupational pulmonary disease in men exposed to "S" fumes and dust from coke fires. Individual susceptibility may be a factor in determining the extent of the disease or disability, and the relative importance in causation of each product of combustion, solid or gaseous, is still undecided. No SO_2 concentrations are given.

522. Editorial: Cancers due to industrial tar and arsenic. J. Am. Med. Assoc. 140:408-10, 1949.

In England a significant increase in cancer among arsenical workers has been reported. However, in the U.S. in 1945 only ca. 20 cases of cancer due to occupational exposure to As are on record in spite of a large consumption of ca. 38,000,000 short tons of white As in the U.S. As is widely used in the production of insecticides, in medicinal preparations, glass, Pb base alloys, dyestuffs, etc. Therefore, many people in industry and agriculture and also the general population, from eating fruits and vegetables in contact with insecticide sprays, are exposed. Similarly, only ca. 75 cases of occupational cancers from industrial exposure to pitch and tar have been reported in the U.S., though in 1945 some 767 million gallons of various types of tars and oils were produced. English investigators report a much greater proportion, e.g., 8 epitheliomas and 13 papillomas in 234 tar workers in 1 case, and 16 epitheliomas and 102 papillomas of the skin among 160 pitch and tar workers during a 12-yr. period. Cancer due to tar and pitch has been steadily increasing in England with 42 cases reported in 1922, 97 in 1930, 119 in 1940, 111 in 1943, 160 in 1944, 176 in 1945 and 201 in 1946. It is concluded that increased attention should be paid by the medical profession to industrial and environmental sources of human cancerigenesis and a sound basis for future control of these cancers be prepared by prompt and complete reporting of such cases.

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523. Grut, A.: Chronic carbon monoxide poisoning. A study in occupational medicine. Copenhagen, Ejnar Munksgaard, 1949, 229 pp.

This book contains a mass of data on the subject of chronic CO poisoning, and presents the conclusions of a great deal of careful, painstaking work. Inherent difficulties of defining chronic CO poisoning are pointed out, various conceptions of chronic CO poisoning are critically analyzed and the following definition is suggested by the author: "a syndrome developing in a characteristic manner, following moderate exposures to CO for some length of time." He deliberately exludes patients with a history of severe acute poisoning, and attempts to distinguish between chronic

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Grut, A. (continued)
poisoning and the sequelae of acute poisoning. Evidence of exposure to CO is discussed, and the accuracy of different analytical methods for CO in air and in blood is evaluated. The author describes a colorimetric method of determining CO in blood, devised by himself, which he claims is satisfactory for field work. The factors governing the rates of absorption and of elimination of CO are considered in some detail, with references to the more important original papers in this field. Some new data on the "normal" proportion of COHb % in individuals not subjected to industrial CO hazards are presented. By examining the blood of nonsmokers, the COHb % was found to be <2 in summer, and <3 in 95 out of 100 persons in winter. The blood of smokers contained on an average 3-4 COHb % in winter and from 2-3 in summer, with a maximum of 7. The symptoms of acute poisoning are described and discussed in some detail, together with data as to the incidence of each symptom in the series of cases investigated by the author. The greater part of the book, however, is devoted to a detailed description and analysis of the author's series of cases of chronic poisoining, comprising a group of factory workers examined during the period 1941-7, and a group of drivers of cars or vans using producer gas as fuel, who were examined during the years 1943 and 1944. A total of 729 drivers answered a questionnaire, and on the basis of the information thus obtained 151 men were selected who reported symptoms suggestive of chronic poisoning. These men were interviewed, and 100 of them were clinically examined. The commonest symptoms were headache, insomnia, fatigue and irritability, dyspnea on exertion and digestive disturbances. The initial symptoms of chronic poisoning usually did not appear until 2-3 mo. after the beginning of the exposure to CO. Heavy smoking did not appear to increase the risk of chronic poisoning despite the increased proportion of hemoglobin combined with CO. It is not clear, however, whether heavy smokers exposed to the same air concentration of CO as nonsmokers, did in fact exhibit a greater proportion of COHb at the end of a day's exposure than did the nonsmokers. In addition to this large group of drivers of cars fueled by producer gas, a small number of garage mechanics, traffic officers and tunnel and locomotive shed workers were examined. There was a considerable incidence of chronic poisoning in some of these groups,especially among the producer-gas mechanics and the tunnel and locomotive shed workers. Men and women employed in the production of coal gas or who used appliances operated by gas, showed a considerable incidence of chronic CO poisoning. Work involving intermittent brief exposures to considerable proportions of CO, as in cleaning the producer-gas equipment of cars, did not result in chronic poisoning. Symptoms of chronic poisoning persisted for 2-4 wk. after removal from the source of CO when poisoning was mild, and for 1-3 mo. when it was severe. After this period recovery was complete. The author considers that human experiments and clinical findings provide no evidence of acclimatization to CO. Considerable variation was observed in the proportion of COHb in the blood at which symptoms appeared but individuals more susceptible in this sense did not appear to be more liable to chronic poisoning. 180 references were cited. (Modification of Abst. Bull. Hyg. 27:1038-9, 1952.)

524. Landahl, H.D. and Tracewell, T.: Penetration of air-borne particulate through the human nose. II. J. Ind. Hyg. Toxicol. 31:55-9, 1949.

The % penetration of various particulates through the human nose was measured on 5 subjects using the apparatus described in the first paper (Ibid. 29:269-77, 1947) with a flow rate of 17 l./min. The results in % mass in cloud fraction, median mass diameter of cloud fraction (μ) and

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Landahl, H.D. et al. (continued)
% penetration for each of the substances are tabulated, and the diameters corresponding to 50% penetration were reported as follows: glycerol, 2.5μ; methylene blue, 6.7; Bi subcarbonate, 4.5; tyrosine, no satisfactory counts made. The role of nasal hair was also measured on 1 subject. 14% of the inhaled glycerol was collected on the nasal hair of 1 nostril; or 21% of the material removed was removed by the nasal hair. The effect of hygroscopicity was found to be significant but not too large.

The quantity, "equivalent impaction diameter," of any particle or aggregate is empirically defined as the diameter equal to that of a spherical particle of unit density which impacts in the same manner as does the particle or aggregate in question. Using this variable, which does not necessitate microscopic determinations, the data from the various materials together with that previously reported are brought substantially into a single curve, thus emphasizing the importance of impaction due to inertial particles in removal of air-borne particulates in the nose.

525. Shilen, J., Mellor, J.F., Koppenhaver, F.B., Cleland, J.G., Galloway, A.E. and Lutz, L.R.: Beryllium - health hazards in the extraction of beryllium oxide from beryl and beryllium alloy manufacture. Ind. Med. 18:109-13, 1949.

Evidence of exposure to BeF_2 dusts in the extraction of BeO from beryl (a Be Al silicate) is presented. Air samples showed concentrations of 0.117 mg. Be/m.^{3} at loading and 0.888 mg. Be/m.^{3} at unloading the furnace. The settled dust contained 1.94% F and 77.4% Be. Dispensary records from this department for the past 2 yr. for respiratory illnesses showed only 1 man who complained of shortness of breath; further examination revealed he had cardiac disease. The authors' X-ray study detected this man and also 1 other man with evidence of pulmonary pathology. The latter man had been a foundry worker for 28 yr. before his employment at the plant investigated. The other X-ray films on the people engaged in the manufacture of BeO were negative. In the pickling department analyses showed an average of 32.95 ppm NO_2 with a range of 13.5-73.9 ppm. The dispensary records indicated treatments for lung involvements in 3 persons during the 2 yr. period. Examination by X-ray of all employees in this department were negative with 1 exception, wherein there was evidence of a mild fibrosis in a man who had not had a dispensary record. Those who had dispensary records for lung involvement had negative findings in the authors' films and in hospital X-ray films after recovering from acute attacks. In the melting department the X-ray findings indicated 3 cases with some evidence of lung markings. 2 of these men worked at the Ajax furnace where they were exposed to F concentrations ranging from 2.01-8.84 mg. F^-/m.^{3}, the average being 4.94 mg./m.^{3}. Settled dust contained 5.64% F and 4.2% Be.

526. Silverman, L., Whittenberger, J.L. and Muller, J.: Physiological response of man to ammonia in low concentrations. J. Ind. Hyg. Toxicol. 31:74-8, 1949.

Seven adult human subjects were exposed at rest to 500 ppm NH_3 gas. The procedure is described in detail. Respiratory minute volume, and, to a lesser extent, the breathing rate, were increased markedly by inhalation of NH_3. Hyperventilation was raised 50-250% above control values and was characterized by periodic fluctuation, with decreases every 4-7 min. of 25% of the minute volume. A transient hypoventilation followed the exposure. Subjective reactions varied considerably but were present in all and severe in 2. The reactions consisted of irritation of the nose and

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Silverman, L. et al. (continued)
throat, hypoesthesia of the exposed skin and lacrimation in 2. In 2 subjects the nasopharyngeal irritation persisted for 24 hr. Ammonia retention decreased progressively until a point of equilibrium was reached, at which ca. 80% of the inhaled NH_3 was returned in the expired air. Most of the retained NH_3 is evidently absorbed in the upper respiratory passages. No significant changes in N metabolism occurred in response to the NH_3 exposures used. It was concluded that exposure to NH_3 at a concentration of 500 ppm is physiologically undesirable, and that the present accepted limit of 100 ppm is probably safe, but needs reexamination. (Condensed authors' summary.)

527. Stokinger, H.E.: Air pollution and particle size-toxicity problem-I. Nucleonics 5, No.6:50-62, 1949.

There are 2 types of industrial air pollution: those affecting the atmosphere of industrial environments, i.e., "neighborhood" contamination, and those occurring within the plant itself. The Donora disaster and the Los Angeles smog problem as known in 1949 are reviewed. The factor of condensation nuclei, such as SO_2 vapor, which plays a determinant role in smog production as well as environmental topography and meteorological conditions, is discussed. For dense cloud formation only 300-500 condensation nuclei/cc. are required; this is easily surpassed in industrial regions. Thus these nuclei are far more important than neutral particulates because of their greater relative number, far greater effectiveness in smog production, greater air-borne potentialities and more severe biologic effects. The episode of the nonoccupational berylliosis near a Be plant is also reviewed.

Several in-plant exposure episodes are discussed. In the case of BeO it was found from electron micrograph, solubility rate and animal studies on various forms of the oxide that toxicity for animal tissues bears some fundamental relation to a limiting surface and particle size. Other studies showed that H_2F_2 vapor in subminimally toxic amounts was found to increase the toxicity of $BeSO_4$ mist. Physical exercise was also found to give the same effect. 7 individuals were exposed to an accidental liberation of ca. 45 $\mu g./m.^3$ BeF_2 fume; 3 were engaged in moderately hard labor at considerable distance from the site; 4 were standing close by but doing no work. The 3 working individuals came down with Be poisoning; no symptoms developed in the others. This was confirmed in animal studies with hamsters. T.b. and Be poisoning have no effect on each other's course. The health problems in the U industry are also discussed.

528. Baetjer, A.M.: Pulmonary carcinoma in chromate workers. I. A review of the literature and report of cases. Arch. Ind. Hyg. and Occupational Med. 2:487-504, 1950.

A survey of the medical literature indicated that cancer of the respiratory tract has occurred in approximately 109 men employed in the chromate-producing industry and in at least 11 men employed in the chrome pigment industry. Practically all the cases were reported in Germany and in the U.S. No morbidity or mortality rates were available for the German cases, but statistical studies in this country indicated that the rates for cancer of the respiratory tract were significantly higher in the chromate-producing industry than would be expected on the basis of comparable groups not exposed to chromates. There were no data to indicate that persons exposed to chromates in other occupations were more than normally liable to cancer of the respiratory tract or that the incidence of cancer in other tissues was excessively high in chromate workers. The majority

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Baetjer, A.M. (continued)
of the cancers in these chromate workers were bronchogenic carcinomas, although a few were located in the upper respiratory tract. In clinical symptoms and pathological changes these cases did not differ in any characteristic manner from cases of lung cancer in general. The lung cancer cases in the chromate workers of the U.S. showed a younger age distribution (average age, 52 yr.) than is normally found for lung cancer cases among males in this country. Some cancers occurred in men who had been exposed to chromates only 4 yr., but the majority did not appear until after many years of exposure (average time, 12-22 yr.). In most cases reported in the literature, the onset of illness occurred while the men were still employed at the chromate plant, but in some cases a number of years elapsed between the termination of employment and the onset of illness. The concentration of chromates in the atmosphere of the plants where these men had worked was not known, since few measurements were made. However, since the majority of the men worked in old plants, they were probably exposed to high concentrations of chromates. The materials which were suggested as responsible for this carcinogenic effect were the hexavalent Cr compounds in the form of dust, particularly the Na and K monochromates or dichromates and Zn chromate. The mechanism of action is not known. Adequate laboratory experiments on this problem are lacking at present. (Author's summary.)

529. Brown, J.H., Cook, K.M., Ney, F.G. and Hatch, T.: Influence of particle size upon the retention of particulate matter in the human lung. Am. J. Public Health 40:450-9, 1950.

A diagram of the apparatus for determining upper respiratory and alveolar deposition of inhaled dust on human subjects is given. China clay dust of various size fractions is atomized into compressed air from solution and the solvent evaporated before inhalation. Exhaled air is collected in a series of 7 collecting bags (by means of a rotary valve) and the dust precipitated by electric precipitation. Each test period lasted ca. 10 min. Analysis of the exhaled air for CO_2 determines the amount of lung (alveolar) air in each bag and the dust concentration of the inhaled and exhaled air is determined. From these analyses and the other respiratory data, calculations determining over-all (R), upper respiratory (U) and alveolar (A) retention and concentration of dust in the lung air and the upper respiratory air can be made (example calculated for 1 exposure is given).

The results from over 100 tests, with median particle size ranging from 0.24μ to >5μ, are graphically summarized. R decreases systemically from ≧90% for ≧5μ mineral particles to 25-30% for 1/4μ particles. U similarly decreases, reaching 0, however, at a finite particle size above 1μ. A (% retention of the number of particles reaching the alveoli) remains between 90-100% for all size >1μ, below which it decreases in proportion to R.

From the curves, the % of inhaled particles deposited in the upper respiratory tract (U_t) and in the alveoli (AP) have been calculated and plotted. U_t decreases steadily from 75-80% (5μ particles) to 0 (>1μ), while AP shows an optimum alveolar deposition ca. 1μ, with decreasing deposition for larger and smaller particles (down to 1/4μ).

530. Dautrebande, L., Capps, R. and Weaver, E.: Studies on aerosols IX. Enhancement of irritating effects of various substances on the eye, nose and throat by particulate matter and liquid aerosols in connection with pollution of the atmosphere. Arch. intern. pharmacodynamie 82:505-28, 1950.

In preliminary experiments, 7 healthy human subjects (4 M and 3 F) were exposed for 10 min. to the following substances with and without oil aerosols, using various solvents (H_2O, alcohol, ether, $CHCl_3$) to test their eye, nose and throat irritating properties: tincture of capsicum, 10%; pepper berry extract; formaldehyde, 2%, 4% and 8%; acrolein, 0.5% and 5 different organic peroxides, 5%. The mean relative humidity in the chamber was 38%±4%. The irritating compounds were dispersed either with an aerosol generator (mean size, 0.2-0.3μ) or by explosion to form aggregates of a size compatible to settling out in the nose, throat and eye (5-25μ). The subjective reactions for eye, nose and throat irritation were recorded as mild (X), moderate (XX) and severe (XXX), and these were summed up. Fresh mineral oil aerosols alone and the above irritants alone were not irritant to the eye, nose and throat, but were definitely irritant when both were simultaneously dispersed at corresponding concentrations. Also used motor oil aerosols alone were irritant.

8-18 normal persons at a time were exposed for 10 min. to each of the artificial atmospheres. These consisted of 0.2-0.5 ppm SO_2 or SO_3 alone, SO_2 or SO_2 with particulate matter (C black containing 10% diesel oil), with used oil aerosols, with used oil aerosols plus C black, with NaCl aerosol or with distilled H_2O, and control experiments with C black (+10% diesel oil) alone, used oil aerosol alone and distilled H_2O. The subjective sensations were recorded as above and tabulated along with the other data. The following conclusions were drawn. (1) SO_2 (concentration ca. 0.5 ppm) and SO_3 (concentration ca. 0.2-0.5 ppm) with or without distilled H_2O aerosol produce practically no irritation of the eye, nose or throat. (2) SO_2 and SO_3 (concentration same or comparable to the other compounds) with ca. 0.07-0.30 ppm C black (with 10% diesel oil), with ca. 1.5-4.0 ppm used motor oil aerosols, or with C black + used oil aerosols, acquire irritative properties. (3) C black alone (0.2-0.3 ppm), used motor oil aerosols alone (1.3-2.0 ppm), or mixtures of both (in ca. comparable concentrations) are by themselves eye, nose and throat irritants. (4) NaCl aerosols (1.1-2.5 ppm) with SO_2 (0.5 ppm) and SO_3 (0.1-0.5 ppm) produce a definite ocular, nasal and pharyngeal irritation.

As applied to Los Angeles atmosphere where the above concentrations of these materials are found, it is possible to assume that the irritant gases and vapors detected there are probably not responsible, as such, for the eye irritation, but that air-suspended matter (either alone or carrying possible irritative gases or vapors), e.g., C black-like material, oily material or NaCl, is. This PM may either be of a highly adsorbent nature (C black) or be able to build up coalescent droplets or large aggregates (oil and NaCl) ≧5μ, which conditions favor the early settling out and the irritant action of the air-suspended material on the eyes, nose and throat. Temperature inversion conditions, which cause smog, are ideal for this.

531. Forbes, J.J., Davenport, S.J. and Morgis, G.G.: Review of literature on Dusts. U.S. Bur. Mines Bull. No. 478, 1950, 333 pp.

This bulletin reviews the following aspects of dust: exposure to dust; physiological effects of breathing dust; incidence of dust diseases; types of dust injurious to health; terminology of dust diseases; pneumoconiosis; silicosis; prevention of dust diseases under which are

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Forbes, J.J. et al. (continued)
discussed principal dust factors producing pulmonary pathology, determination of dust in air, engineering control, medical control and general recommendations for control of dust diseases in industry; economic and legal aspects of dust diseases in industry; cost of compensation for silicosis and determination of working capacity. An extensive bibliography of 657 references is given.

532. Friberg, L.: Injuries following continued administration of cadmium. Preliminary report of a clinical and experimental study. Arch. Ind. Hyg. and Occupational Med. 1:458-66, 1950.

In the examination of 43 workmen exposed to Cd and Ni dust in an alkali storage battery plant the following signs and symptoms of pathologic effects were found. (1) Anosmia. In 14 out of 43 and partial in 2. (2) Pulmonary emphysema. Statistically proved by using controls of same age distribution. (3) Low physical working capacity. Revealed by using ergometer and controls of same age distribution. (4) Impairment of renal function. Inulin clearance in 19 men averaged 90.4±5.6 cc./min.; controls averaged 124.1±2.2 (n=36) cc./min. Concentration tests showed specific gravity below normal in 30 of 43 and average in 12 (1 with only 1 kidney). (5) Proteinuria. In 28 of the 43 with HNO_3 test and 35 in the 43 with trichloroacetic acid; usually strongly positive. Microscopically urine was normal. (6) Increased sedimentation rate. RBC sedimentation rate determined on the 43 with results from 1-94 mm. (average 24±3 mm.)/min. (7) Impairment of hepatic function. Liver function test on 19 showed possibly a few cases of slight parenchymal injuries. These men were employed from 9-34 yr. (average 20.2±1.0). Another group of 15 men who were employed for 1-4 yr. (average 2.1±0.3) were also examined, but hardly any symptoms were found.

Tests of urines from workmen at similar factories in England, Germany and France corroborate Swedish experience. Proteinuria was found in 3 French workmen who were exposed only to Cd, whereas 8 men who were exposed only to Ni lacked this sign of pathologic change. This fact is an indication that the proteinuria is due to the inhalation of Cd and not to that of Ni. Some experiments involving inhalation and subcutaneous exposures of Cd dust on rabbits were also carried out.

533. Glebova, L.F.: (Maximum allowable concentration for hydrogen sulfide in the atmosphere.) Gigiena i Sanit. 1950, No. 4: 19-21.

Analysis of air samples taken at a distance of 1 km. from a viscose plant revealed the following contamination of the air (average concentrations given in mg./m.^{3}): H_2S 0.05 and CS_2 0.075. In 1947-8, 90 infants, ranging in age from 1 mo. to 3 yr., who stayed at the plant nurseries 800 m. and 2 km. away from the plant were examined. Several of the nursing infants were found to be in a poor state of nutrition, asthenic and anemic. They showed gastrointestinal disorders, increased susceptibility to infectious diseases and retardation of growth, i.e., development of teeth, walking, etc., which is illustrated by 2 case reports. It was established that the mothers, when coming over to the nursery from their work in the spinning room of the plant, nursed the infants without changing their clothes. Immediately or 30-40 min. after nursing, the infants vomited, which also happened when the mothers wore coats over their work clothes. The connection between the mothers' exposure and the conditions observed in the infants was demonstrated when the mothers were transferred to another section of the plant where no such exposure was present. The vomiting of the infants disappeared, and the conditions of the children

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Glebova, L.F. (continued)
improved. Since there was an obvious relationship between the children's contact with the contaminated work clothes of the mothers and the symptoms seen in them, analyses of the air under these clothes were carried out, controls being provided by taking similar air samples from women working in plant sections other than the spinning room. The results were negative for CS_2 but showed the presence of H_2S at 0.028-0.055 mg./m.^{3}, i.e., at the level of the present MAC for H_2S. All control results were negative. It was surmised that the described symptoms were due to the cumulative effect of H_2S on the infants who had not yet developed the proper resistance to the substance. The fact that very young infants are more susceptible to H_2S and that disorders of the gastrointestinal tract like those described here severly disturb their growth and development should lead to a revision of the MAC for H_2S.

534. Sjöberg, S.: Vanadium pentoxide dust. A clinical and experimental investigation on its effect after inhalation. Acta Med. Scand. 138, Suppl. 238, 188 pp., 1950.

This is an extensive discussion of V_2O_5 dust thoroughly covering the following topics: discussion of the physical and chemical properties of the element V, its physiologic function, pharmacological effect and toxicity; manufacture of V_2O_5 in the Falun Copperworks; dust in the plant; risk of occupational disease; cases of illness; discussion of the symptoms and the results of clinical and laboratory examinations and experimental investigations on animals. For the report on clinical and experimental findings, see abstract, Sjöberg, S.: Health hazards in the production and handling of vanadium pentoxide. Arch. Ind. Hyg. and Occupational Med. 3:631-46, 1951.

535. Thorp, C.E.: The toxicity of ozone. A report and bibliography. Ind. Med. Surg. 19:49-57, 1950.

This paper presents data on O_3 toxicity based on experiments and experience of Armour Research Foundation staff members, supplemented by a critical evaluation of the published work of other investigators. It is shown that much of the early work on this subject was with O_3 in air inadvertently contaminated with N oxides. Inasmuch as the toxic limits of mixtures of these 2 substances in air are distinctly lower (1.0 ppm) than for either pure N oxides (20 ppm by weight) or pure O_3 alone (20 ppm by weight), it is easily understood why O_3 was considered by many to be a highly toxic substance. Later workers, taking cognizance of the synergistic effect of N oxides, found O_3 tolerance by human beings to be far higher than previously suspected, even as high as 50 ppm. A graph is presented showing O_3 concentrations and duration of exposure required to produce various physiological effects classified as: nonsymptomatic, nontoxic symptomatic, nontoxic irritant, temporary toxicity, permanent toxicity and fatal. The limits of the permanent toxicity and fatal zones are only estimates, inasmuch as the study of physiological effects with these very high concentrations (1-30 weight %) has not been undertaken. The absence of reported fatalities is attributed to the fact that heretofore concentrations of potentially lethal order have not been encountered on any appreciable scale. It is evident that lower concentrations of pure O_3 of the order of 50 ppm have no cumulative effect. Treatment based on that recommended for other gaseous oxides is described for ministering to subjects exposed in the permanent toxic range. Precautions in handling liquid O_3 of various concentrations in liquid O_2 are outlined, and means for preventing the accumulation of high gas concentrations during evaporation of liquid are described. A bibliography of 98 references is included. (Author's summary.)

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536. Vorwald, A.J.: Variations in individual susceptibility to industrial dusts inhaled into the lungs. Am. Rev. Tuberc. 62, No. 1B:13-21, 1950.

The many phases of individual variations in pulmonary response to inhaled dust are reviewed; from these considerations it is evident that there is no simple explanation for this puzzling phenomenon. Not all subjects exposed to dust under presumably the same environmental conditions react alike. Some are susceptible and respond early; others are partly or almost completely resistant. This condition occurs both with the experimental animal and with the industrial worker inhaling atmospheres contaminated with dust. Various explanations have been offered to account for these differences, but none is entirely satisfactory. Inefficient nasal filtration, physiologic peculiarities of the lungs, chronic infection of the respiratory tract, effectiveness of the lymphatic drainage system, quantity of dust deposited in the lungs, particle size, metabolic and genetic factors and physicochemical differences have been suggested as possible determinants influencing the degree of pulmonary reaction of the individual man or animal exposed to a dusty environment. The relative importance of each of these elements in the production of pulmonary dust disease in some workers and not in others remains to be determined.

537. Zander, R.: Über Schwelgasvergiftungen. (Poisoning by gases from low-temperature carbonization of soft coal.) Deut. Gesundheitsw. 5:1422-4, 1950.

In the production of tar, medium and light oil, certain gases are developed as by-products during the low-temperature carbonization of soft coal. Depending on numerous factors, the composition of these gases may show variations of up to ± 10%, except for H_2S which may vary by ± 20%, i.e., from 1.6 to 2.4 vol. %. The yearly average content is given as follows (vol. %): N, 47.1; CO_2, 17.8; H, 11.3; CH_4, 10.4; CO, 10.3; H_2S, 2.0; heavy hydrocarbons, 0.8; O_2, 0.3; the specific gravity is 0.933. Poisoning due to the inhalation of this gas mixture is essentially H_2S or CO poisoning or both combined; the other components are less injurious, due either to their nature or their low concentration. The prolonged inhalation of 0.04-0.1% of H_2S may endanger life. Two principal types of H_2S poisoning may be distinguished: the apoplectiform, characterized by sudden collapse, and the tetaniform, where loss of consciousness is followed by deep coma and convulsions. Low concentrations of H_2S cause vertigo and nausea. In CO poisoning, the CO combines with the blood Hb to form COHb. Typical symptoms are: throbbing headache, fatigue, conditions of confusion, excitation, as well as loss of consciousness. Sequelae may remain, such as pneumonia, cardiac disorders or paralysis. From August 1948-July 1950, the author observed 22 cases of poisoning due to the described gas mixture, the symptoms varying with the qualitative composition of the gases and the duration of exposure. The times of hospitalization ranged from 1-16 da., with an average of 5 da. 4 typical case reports are given, representing the clinical picture seen in poisoning caused by H_2S, both apoplectiform and resulting in bronchopneumonia, and CO, although the symptoms resemble those produced by exposure to low concentrations of H_2S. Only one chronic case of poisoning due to exposure to the gas mixture was observed. The patient's complaints included asthemia, cough, conjunctivitis, headache, vertigo and gastric disturbances, all gradually exacerbating. There were no objective gastric findings. 20 chest X-rays and 11 electrocardiographs were taken during the patients' hospitalization. They revealed very few pulmonary changes, 2 previous, now healed conditions, the above mentioned bronchopneumonia and 1 early tuberculous infiltration, as well as 4 myocardiac conditions.

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Zander, R. (continued)

Therapy of poisoning due to the inhalation of the gas mixture consists mainly of the administration of O_2 and, if necessary, of 6-10% CO_2, as well as of medications supporting the circulation.

538. Ahlborg, G.: Hydrogen sulfide poisoning in shale oil industry. Arch. Ind. Hyg. and Occupational Med. 3:247-66, 1951.

In the Swedish shale oil industry there has been considerable exposure to H_2S, owing to the high concentration of S in the shale layers. Other gases have played only minor or inconsiderable parts as intoxicating agents. The frequency of acute and subacute H_2S poisonings within the shale oil industry has been high. Many of the reports in the literature of these are reviewed. The former have manifested themselves in sudden but transient unconsciousness, sometimes accompanied by sequelae with neurasthenic symptoms and disturbance of equilibrium. In 1 worker with lengthy but moderate exposure there were cramps and circulatory collapse; in another, transient disturbance of the basal ganglions. Six cases of sequelae of acute H_2S poisoning have been described in detail. No patient has shown signs of pulmonary edema. There have been no deaths. The subacute poisonings have been characterized by intense keratoconjunctivitis which, with proper treatment, healed after approximately 4 da. Other symptoms of involvement of mucous membrane have been insignificant, and no permanent injury of the eyes has occurred. The existence of so-called chronic H_2S poisoning was tested by comparing the subjective complaints of 2 groups of workers. 1 group was exposed to H_2S in their daily work, often to $>0.002\%$; the other group was only occasionally exposed to H_2S, but were more exposed to dust. Complaints concerning the mucous membranes of the eyes and the respiratory tract were slightly more frequent in the 1st group, and those concerning the back, sleep and the stomach were approximately on the same level in both groups. However, the so-called neurasthenic troubles, viz., fatigue, loss of appetite, headache, irritability, poor memory, dizziness and itching show a higher frequency in the more highly exposed group 1. The dominating symptom was fatigue. The frequency of neurasthenic troubles also increases with the length of employment.

539. Collings, G.H., Jr., Fleming, R.B.L. and May, R.: Absorption and excretion of inhaled fluorides. Arch. Ind. Hyg. and Occupational Med. 4:585-90, 1951.

Two human subjects were exposed for an 8-hr. period to atmospheres containing approximately 3.3 mg. gaseous F (HF and SiF_4)/m.^{3} air, and approximately 5 mg. "insoluble" F dust (rock phosphate containing 3.5% F) /m.^{3} air. The total daily F output in urine following exposure was as follows:

	Subj. GHC*		Subj. RF**	
Day	Gas exposure	Dust exposure	Gas exposure	Dust exposure
Day of exposure	9.64	10.00	8.56	9.95
1st day after exposure	1.67	1.96	2.49	2.99
2nd day after exposure	0.99	1.28	1.31	1.10
3rd day after exposure	0.89	0.73	1.34	0.98

Normal urinary output: *0.9 mg./day; **1.2 mg./day

Thus a single exposure of 8-hr. duration to approx. 3.3 mg. gaseous F/m.^{3} resulted in an elevation of the rate of urinary excretion of F to approx. 8.1 mg./day, and that to approx. 5 mg. "insoluble" F dust/m.^{3}, to approx. 8.9 mg./day; also, as determined by the analysis of serial urine specimens, exposure to atmospheres containing either gaseous F or particulate F

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Collings, G.H., Jr. et al. (continued)
produced the same changes in the rate of the urinary excretion of F over a period of time. In proportion to the respective atmospheric concentration, the total amount of F excreted after exposure to gaseous F was slightly greater than was the amount excreted after exposure to F dust, but the equal rapidity of urinary changes occasioned by these 2 types of exposure would indicate that the 2 forms of F are equally well absorbed by the lungs. Under conditions of usual industrial work in which 8 hr. of exposure are followed by 16 hr. of freedom of exposure, it is to be expected that the elevation of the rate of urinary F excretion occasioned by the exposure during one work shift will have returned to normal before the next shift begins. A slightly elevated rate of excretion may persist into the next shift, but the magnitude of this carry-over would be unimportant in proportion to the rate of F excretion produced by the repeated exposure. (From authors' summary.)

540. Dautrebande, L., Shaver, J. and Capps, R.: Studies on aerosols XI. Influence of particulate matter on the eye irritation produced by volatile irritants and importance of particle size in connection with atmospheric pollution. Arch. intern. pharmacodynamie 85:17-48, 1951.

The eyes of 3 normal, trained male subjects were exposed for 3-min. periods to controlled atmospheres containing 0.002-0.019 mg./l. air of the following: mixed HCHO, HNO_3, H_2SO_4 aerosols alone ("vapors"); vapors plus particulate matter (PM), i.e., NaCl aerosols, silica suspensions, used motor oil aerosols; vapors plus PM without oil aerosols; vapors plus oil aerosols, without NaCl aerosols and fine SiO_2 dust; total PM alone, i.e., NaCl aerosols, SiO_2 dust, used motor oil aerosols; PM without oil, i.e., NaCl aerosols and SiO_2 alone and used oil aerosols alone. The degree of subjective eye irritation, the degree of irritation of the oculonasal ducts, the amount of lacrimation and the blink rate were observed every 15 sec. The results along with concentration of the various constituents are tabulated and the following conclusions drawn. The reaction to a given atmosphere may vary largely from 1 subject to another. The reaction of the same subject to a given atmosphere may vary from 1 exposure to another. PM (NaCl aerosols, fine SiO_2 dust and used oil aerosols) added to HCHO, H_2SO_4 and HNO_3 aerosols regularly and notably enhanced the eye irritation on all 3 subjects. NaCl aerosols and fine SiO_2 dust without used oil aerosols added to the vapors enhanced the irritation produced by the vapors in every case on 2 subjects and inconsistently on the 3rd subject who had a high irritation threshold. HCHO, HNO_3, H_2SO_4 aerosols plus used oil aerosols (without SiO_2 dust and NaCl aerosols) produced a stronger irritation than with vapors alone, on the 2 subjects exposed. PM alone required a much higher concentration (0.02 mg./l.) to produce eye irritation than when the vapors were present in the air. NaCl aerosols and fine SiO_2 dust (without the vapors and oil aerosols) did not produce any noticeable irritation even at concentrations 40 times above the threshold (0.8 mg./l.) as found for irritant vapors. Used oil aerosols alone produced an ocular irritation during the 3-min. exposure, but only at a much higher concentration than when the vapors and PM were present in the various combinations.

Electron microscope photographs were taken of aerosols containing HCHO, HNO_3, H_2SO_4, NaCl, used oil, SiO_2 and C black (India ink) at various concentrations (0.000001-0.000033 mg./l. air). The aerosols appeared in 3 states: a) a very large number of discrete shadowed particles, mean size ca. 0.05μ; b) long (1-7μ) well-shadowed chain aggregates containing a very large number of individual small particles; c) nonshadowed coalescent,

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Dautrebande, L. et al. (continued)
spreading aggregates (1-10μ). The collodian background covered by the flat aggregates seemed in most cases to have been somewhat corroded or "digested" by the material collected, and is considered to be the most responsible for the eye, nose and throat irritation. H_2O emulsions of used motor oil at similar concentration gave practically the same photographic appearance. Particulates this size (c) have been found in Los Angeles atmosphere and are known to be retained in the upper respiratory tract.

541. Freitag, R.: Gefahren beim Umgang mit Schwefeldioxyd. (Sulfur dioxide hazards.) Erdöl und Kohle 4:569, 579, 1951.

Although SO_2 is used in numerous industrial processes, the exposure to harmful concentrations generally is confined to accidents or careless handling. SO_2, even at low concentrations, has a pungent smell, and, due its solubility in H_2O, can be greatly reduced in concentration by spraying with H_2O. Experimental exposures have demonstrated that 0.02-0.03 mg. SO_2/l. of air can be tolerated, and 0.06 mg./l. was tolerated for 0.5 hr. In workers accustomed to the exposure, even 0.1-0.2 mg./l. did not cause irritation of the air passages. This obvious adaptation to the exposure to SO_2, also proved experimentally, explains that effects on humans are observed mostly in newly employed workers. Persons hypersensitive to SO_2 should avoid any exposure. Of the symptoms observed following the inhalation of higher concentrations of SO_2, these are mentioned: a feeling of constriction and suffocation, attacks of coughing and spasms of the glottis, all of which prevent the penetration of the SO_2 into the lower parts of the respiratory tract. There is always considerable irritation of the mucosae of the eyes. In case of severe SO_2 poisoning, catarrhal bronchitis and lobular pneumonia may lead to death. Skin irritations usually are only observed in hypersensitive persons. An accident in a sulfide cellulose plant caused 20 fatalities due to SO_2 poisoning and produced late dyspneic effects, occurring several months later, in the other exposed workers. (Accident described in detail in: Deut. Arch. klin. Med. 168:107, 1930, by author.) The beneficial effect of the therapeutic administration of SO_2 on catarrhal inflammation of the air passages, as well as precautionary measures and therapy with regard to SO_2 poisoning are discussed. The latter consist mainly of the wearing of protective masks and the application of fresh air and O_2 immediately after exposure to high concentrations of SO_2.

542. Landahl, H.D., Tracewell, T.N. and Lassen, W.H.: On the retention of airborne particulates in the human lung: II. Arch. Ind. Hyg. and Occupational Med. 3:359-66, 1951.

Twenty-one male and 3 female subjects breathed in 0.25μ size triphenyl phosphate particles at a rate of 18 l./min. in a 12-sec. cycle. The amount retained in each of the 4 sections of the respiratory tract represented by 4 serial fractions of expired air was calculated and expressed in terms of % of the total retained. Since the subjects were inexperienced, the breathing was less apt to be uniform, and correlation of retention with height and weight was only suggestive. The average retention for the males was 41% ± 5.1 (with a range of 33.53%); for the female 47.3%, showing some sex difference. The experiment was also carried out on 6 male subjects with an 8-sec. cycle using 6.3μ size dust. Retention varied 90-96%. 2 subjects breathed various size particles, ranging from 0.11-6.3μ in 4, 8 and 12-sec. cycles at 18 l./min. The results of each of the 4 serial fractions of expired air are tabulated and graphed; they show

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Landahl, H.D. et al. (continued)
minimum retention for 0.55μ particles. The results compare favorably with theoretically calculated values.

543. Largent, E.J., Bovard, P.G. and Heyroth, F.F.: Roentgenographic changes and urinary fluoride excretion among workmen engaged in the manufacture of inorganic fluorides. Am. J. Roentgenol. Radium Therapy 65:42-8, 1951.

Samples of urine obtained from 23 employees (age 30-72 yr.) of 2 factories in which inorganic fluorides are manufactured contained F in concentrations that ranged from normal levels of less than 1 mg./l. to abnormal average levels as high as 28 mg./l. The lengths of service ranged from 6-26 yr. 5 workmen of 16 who were examined roentgenologically showed increases in bony density. These men had excessively and consistently higher concentrations of F in samples of their urine than did the employees whose bones were normal in density. Among the workmen whose bones showed increased opacity to roentgen rays, only 2 were found in whom the bone changes were marked. Neither of these workmen was demonstrably disabled. There was little or no evidence of hypertrophic changes in the vertebrae in the regions of increased density. The average urinary F concentrations and absence or presence of increase in density of bones as seen roentgenologically were as follows: 0.70-6.51 mg./l., no increase in density; 9.30-12.29 mg./l., slight increase; 11.65 and 16.38 mg./l., marked increase.

544. Princi, F.: Environmental health aspects of certain agricultural pesticides. Agr. Chemicals 6, No. 2:30-3, 1951.

The important environmental health aspects of pesticides which require serious study are (1) the manner in which the compound is to be used; (2) the physical state of these compounds; (3) the amounts of the compound to which workers are likely to be exposed; (4) the effects of these amounts on the human organism; (5) the routes of absorption which can be expected and (6) other chemicals with which they will be formulated, and the influence of the latter on the toxicity, physical state and absorbability of the agent under examination. The full elucidation of these items demands a knowledge not only of the physiological action of the material, but also of the maximum degree of exposure which may be permitted without expected damage to the organism. Only by careful use and proper study of exposed persons can such adequate information be obtained.

545. Roche, L., Morel, S. and Guillermet, J.: Leucosarcomatose plasmocytaire chez un ouvrier exposé à inhaler des vapeurs de brai. (Plasmocytic leucosarcomatosis in a worker exposed to the inhalation of tar vapors.) Arch. mal. prof. 12:48-50, 1951.

The disease described in this report was observed in a 46-yr. old former mason who had worked for the last few years in a plant manufacturing refrigerators. It was his job to install the insulation consisting of cork sheets fastened with melted gas tar. During the heating of the tar in the unventilated room, irritating vapors were produced. No exposure times or concentrations are given. The patient's anamnesis did not demonstrate any serious previous or present diseases except a former syphilis which was now under control. 3 mo. prior to admission to the hospital, the following symptoms were noted: dyspnea, particularly at night, bronchial signs and abundant expectoration. On admission, the examination revealed these symptoms: bronchial rales in both lung fields, radiological evidence of marked fibrosis, soft, enlarged spleen, hypertrophic liver, multiple small adenopathic signs, pains in sternal left and in tibial regions and facial

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Roche, L. et al. (continued)
pallor. In the blood count, the decrease in number of erythrocytes and the low Hb (31%) indicated anemia. The condition was further characterized by an invasion of plasmocytes, some in amitosis, in the bone marrow, signs of possible plasmocytic leucosis and of reticulosarcomatosis. There was no evidence of t.b. in the sputum. The patient's condition exacerbated; the temperature, however, did not surpass 38 C.; gingival and intestinal hemorrhages appeared. One month after admission to the hospital, the patient died. The autopsy results are given as follows: weight of liver, 4.4 kg., of spleen, 1.25 kg.; the mediastinal and mesenteric ganglia were normal, several hard nodules were found in the pancreas. There was a bilateral serofibrous pleural effusion (500 cc.) and some congestion on the base of the lungs. The histologic examination revealed an infiltration of mononuclear cells in the following organs: liver, spleen, kidneys, axillary glands, bone marrow, periosteum and pancreas. The lungs showed edematous alveolitis and dilatation of capillaries but no mononuclear cell infiltration. All the mononuclear cells observed were malignant plasmocytes, indicative of sarcoma rather than of plasmocytoleucosis. They were found either as plasmocytic thrombi obliterating the blood vessels, or they were located around the blood vessels. The described findings justify, according to the author, the diagnosis of leucoplasmocytosarcomatosis. It is stated, however, that the clinical picture observed did not provide sufficient evidence for establishing the occupational exposure as the cause of the hemopathy. It is suggested that further studies of the problem tar and its action on the hematepoietic organs be carried out.

546. Sjöberg, S.: Health hazards in the production and handling of vanadium pentoxide. Arch. Ind. Hyg. and Occupational Med. 3:631-46, 1951.
The previous reports on V poisoning are reviewed. The results of the author's investigation of the action of inhaled V_2O_5 dust on man are reported as follows. Shortly after a new factory for the production of V_2O_5 was opened in Falun, Sweden in 1946, illnesses began to occur. The main symptoms of 36 workers observed during 1947-50 were severe irritation of the respiratory tract, dryness and pain in the throat, a viscid sputum, shortness of breath and palpitation on exertion, weakness and fatigue and slight irritation (redness) of the conjunctivae with little or no inconvenience. Other symptoms that occurred in some of the cases included bronchopneumonia, nasal catarrh or smarting of the eyes, skin disease in the form of papular eruptions on the face, hands and dorsa of the feet, neurasthenia and giddiness, and in one, tremor for a short period. Symptoms appeared in different combinations and degrees. A detailed description of the symptoms of the respiratory tract, the chief clinical symptoms, is given. Both the observed and previously reported effects on the gastrointestinal tract, the circulatory system, blood, liver and skin are also discussed. General poisoning by V, though possible, is considered to be of a mild nature and of no great significance. The disease caused by V_2O_5 dust is of an acute nature; the symptoms appeared within a week after the 1st inhalation, lasted from several da. to a few mo., and then, in most cases, subsided. Diagnosis, therapy and prophylaxis are also discussed. The action of the dust on animals was also investigated. The dust used contained ca. 99.9% V_2O_5 and 33% were below 10μ in size. 13 rabbits were exposed to high concentration of dust for 1 or 2 da. and then subjected to autopsy; 6 rabbits were exposed as the preceding group, but were allowed to recover for 24 da., and then autopsied and 12 were exposed for 1 hr./day for a total period of 8 mo. and then autopsied. The

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Sjöberg, S. (continued)
animals in group 1 showed conjunctivitis, acute laryngotracheitis, acute bronchopneumonic patches containing particles of V_2O_5 dust, fatty degeneration of the liver, increased varying content of V in most organs, enteritis in some cases. The animals in group 2 showed slight chronic tracheitis, atelectatic (apparently postpneumonic) areas of the lungs and areas with dilated alveoli. No dust was found in the lungs of some of the animals, although the V content of most of the examined organs, including the lungs, was high. The animals in group 3 showed chronic inflammatory changes in the nasal and tracheal mucosa, emphysema of the lungs and bronchopneumonic patches, probably reduced elasticity of the lung, small round cell infiltrations of the liver (probably of infectious origin), pyelonephritic changes in some cases, varying increased content of V in the examined organs except the intestine. The animal experiments thus, in general, confirmed the clinical observations. However, no clinical features correspond to the emphysema and the postpneumonic atelectasis or the bronchopneumonic atelectatic changes demonstrated in the animals or to the enteritis which was present in some of the animals exposed for a short period.

547. Snegireff, L.S. and Lombard, O.M.: Arsenic and cancer. Observations in the metallurgical industry. Arch. Ind. Hyg. and Occupational Med. 4:199-205, 1951.

For 130 years, As has been considered a possible cause of cancer. Various papers which discuss the occurrence of As in the earth's crust and in cigarettes, the use of As in medicine and the occurrence of cancer after prolonged treatment with arsenicals are reviewed. This possibility of cancer susceptibility from treatment with arsenicals was then investigated by observing workers in the metallurgical industries who have handled large quantities of arsenical compounds, e.g., As_2O_3, and thus been exposed, over many years. The clinical and death records of employees, medical histories and clinical examinations on workmen long employed in the As production in Plant A are analyzed statistically and compared with those in Plant Z in which no As production occurred. During the previous 25 yr., 7 respiratory cancer deaths out of 18 total cancer deaths were recorded. The occurrence of these deaths were sporadic. This proportionate mortality was slightly higher than that of the state. However, the same proportionate mortality was also found in Plant Z where As was not handled but where other factors were comparable. Statistical tests showed that these differences are chance fluctuations and are not significant. It is concluded that the handling of As_2O_3 in the industry studied does not produce a significant change in the cancer mortality of the plant employees; hence other factors in addition to As must be considered significant in the causal relationship to cancer.

548. Truche, M.R.: La toxicité de l'ozone. (Toxicity of ozone.) Arch. maladies profess. méd. travail et securité sociale. 12:55-8, 1951.

Several workers in the laboratory of a plant producing porcelain insulators reported complaints of very similar nature. They were engaged in the testing of insulators by both electric arc and high frequency current methods, which involved working with currents of 0-125,000 volts and of 50,000 volts, 200,000 rpm. The symptoms, which usually occurred 1-2 hr. after the beginning of the work, are described as follows: sensations of compression in the epigastric region and of constriction of the thorax, dyspnea, labored inspiration, irritation of the larynx, cough, sensation of burning in the tracheal region, conjunctivitis accompanied by

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Truche, M.R. (continued)
lacrimation. While the cough quickly disappeared under the influence of fresh air, the dyspnea persisted for a much longer time and often prevented sleep at night for several hours. There was pronounced asthenia, but none of the workers complained about headache. No analytical results, qualitative or quantitative, of the air in the work room are given. The physical and chemical properties of O_3, its uses, including its therapeutic applications, as well as its toxicity are reviewed. The synergistic effects of N oxides and O_3 are stressed.

549. Wilska, S.: Ozone. Its physiological effects and analytical determination in laboratory air. Acta Chem. Scand. 5:1359-67, 1951.
The properties, physiological activity and analytical determinations of O_3 that are reported in the literature are reviewed. The concentration of O_3 in the vicinity of a spectrograph has been determined iodometrically and was found to rise to 1 ppm in 1 hr. The O_3 concentration near an UV lamp was found to be below the limit of determination, 0.1 ppm. The author worked with a spectrograph, using 3-4 min. exposure times, for 3-4 hr. at a time. After 2 wk., distinct symptoms of chronic O_3 poisoning were observed, i.e., shortness of breath and continuous headache. It was evident that the ventilation was not sufficient to eliminate the possibility of O_3 poisoning. The author stresses that the toxicity of O_3 should be better known, and considered wherever O_3 may be formed.

550. Adams, E.M. and Schneider, E.J.: Eye irritants formed by the interaction of styrene and halogen in the atmosphere. Proc. Air Pollution Smoke Prevention Assoc. 45:61-4, 1952.
In a large chemical plant difficulties due to eye irritation were traced to a lacrimator formed by the interaction of styrene with Cl_2 or Br_2 in the atmosphere. 3 such episodes and the measures taken for their control are reported. 3-5 subjects were exposed each time to both UV-irradiated and nonirradiated Br_2 (0.10-0.21 ppm) and Cl_2 (0.01-0.11 ppm) alone and to combinations of styrene (0.2-1.2 ppm) with Cl_2 (0.002-0.016 ppm) or Br_2 (0.005-0.013 ppm). The test period was initially 3 min. and then it was standardized to 10 min. Nonirradiated Br_2 was irritant at 0.21 ppm, and UV-irradiated Cl_2 at 0.11 ppm. Only 0.005 ppm Br_2 with 1.2 ppm styrene and 0.016 Cl_2 with 1.2 styrene caused prompt irritation and 0.002 Cl_2 and 1.2 styrene caused irritation in 3 min. The formation of the irritant in laboratory experiments was catalyzed by UV radiation, and in practical circumstances seems to be dependent upon the presence of sunlight.

551. Amdur, M.O., Silverman, L. and Drinker, P.: Inhalation of sulfuric acid mist by human subjects. Arch. Ind. Hyg. and Occupational Med. 6:305-13, 1952.
Normal human subjects of various ages inhaled concentrations of H_2SO_4 mist varying from 0.35-5 mg./m.^{3} through a face mask while resting. Particle size of the mist averaged 1μ. The retention of inhaled H_2SO_4 from 22 determinations averaged 77%. Changes in respiration in all the subjects were observed and measured by a pneumotachograph. Results on 5 subjects exposed to concentrations of 0.35 mg./m.^{3}, 5 to 0.4 mg./m.^{3} and 5 to 0.5 mg./m.^{3} showed increase in respiration rate, but with expiration taking a greater % of the total cycle and a decrease in tidal volume. After exposure breathing returned to normal. Since retention of inhaled acid mist decreases when the respiration rate increases, these changes in respiration appear to be a reflex protective mechanism to

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Amdur, M.O. et al. (continued)
prevent retention of the acid mist. At concentrations of 5 mg./m.^{3}, levels at which the acid mist was easily detected by all, changes were more pronounced but also more varied in nature. The main response at this concentration was a decrease in minute volume. Pneumotachographic tracings are given for various concentrations before, during, at end and after exposures. The possible significance of these findings is discussed.

552. Beyer, E., et al.: Industrial Toxicology. In: Oxford Medicine. Vol. IV, Part IV, N.Y., Oxford University Press, Inc., 1952, Chapter XIX, pp. 595-663(214).

This chapter contains reviews on the industrial hygiene, pharmacology and toxicology of the following substances with an introduction (I) by A. Hamilton.

McCord, C.P.: II. Inorganic acids and their anhydrides.
Hamilton, A. and Johnstone, R.T.: III. Alkalies.
McCord, C.P.: IV. Acute and chronic fluorosis and fluoride dental prophylaxis.
McCord, C.P.: V. Arc welding.
Teleky, L.: VI. Aluminum.
Buchan, R.F.: VII. Antimony.
Buchan, R.F.: VIII. Arsenic.
Buchan, R.F.: IX. Barium.
Hardy, H.L.: X. Beryllium.
Princi, F.: XI. Cadmium.
Buchan, R.F.: XII. Chromium.
Buchan, R.F.: XIII. Copper.
Mayers, M.R.: XIV. Lead poisoning.
Tabershaw, I.R.: XV. Magnesium.
Buchan, R.F.: XVI. Manganese.
Buchan, R.F.: XVII. Mercury.
Buchan, R.F.: XVIII. Nickel.
Hamilton, A.: XIX. Phosphorus.
Buchan, R.F.: XX. Selenium.
Buchan, R.F.: XXI. Silver.
Buchan, R.F.: XXII. Tellurium.
Teleky, L.: XXIII. Thallium.
Buchan, R.F.: XXIV. Vanadium.
Buchan, R.F.: XXV. Zinc.
Teleky, L.: XXVI. Zinc fever, weaver's fever, dust chills, cotton mill fever.
Smith, A.R.: XXVII. Cyanides.
von Oettingen, W.F.: XXVIII. Carbon monoxide.
Hamilton, A. and Johnstone, R.T. XXIX. Carbon disulfide.
Haggard, H.W.: XXX. Hydrogen sulfide.
Hamilton, A. and Johnstone, R.T., rev. by Hardy, H.L.: XXXI. Ionizing radiation.
Hamilton, A. and Johnstone, R.T.: XXXII. Aromatic or benzine series of solvents.
Foulger, J.H.: XXXIII. Dye intermediates and urinary bladder tumors.
Machle, W. and Beyer, E.: XXXIV. Petroleum and its products.

553. Collings, G.H., Jr., Fleming, R.B.L., May, R. and Bianconi, W.O.: Absorption and excretion of inhaled fluorides; further observations. Arch. Ind. Hyg. and Occupational Med. 6:368-73, 1952.

An industrial employee (LHG) who had been exposed to fluorides in the air during 8 yr. of work and a control subject (GHC) without significant

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Collings, G.H. et al. (continued)
prior exposure were exposed simultaneously for 6 hr. to atmospheric concentrations of fluorides averaging 4.8 mg. F/m.^{3} of air. Urinary excretion of F by the 2 subjects rose during the exposure and fell rapidly to near preexposure levels within 24 hr. The base level of F excretion (during times when no exposure had occurred for several days) was slightly higher for LHG than for GHC, 2 mg. F/day as against 1 mg. F/day, which is considered to be a measure of the excretion from previously stored F in LHG. However, the transient rise of urinary F excretion above the base level, produced by 6 hr. of exposure to air containing F, was very nearly the same for the 2 subjects, both in time and in amount; i.e., 4 mg. for LHG and 5 mg. GHC (total quantity of F excreted above the subjects' respective base levels during the first 24 hr. following above exposure). A second industrial employee (SR) with an even greater past exposure to F, evidenced by urinary concentrations at the end of 8 hr. regular work of from 14-30 mg.F/l., showed a similar excretion pattern following exposure for 8 hr. to air-borne F at his work location (F content not determined). He was known to have a base-level urinary excretion of about 3.5 mg. F/day. He also showed a rapid fall in urinary excretion from 1.15 mg. F/2 hr. at the end of his 8-hr. workday to about 0.30 mg. F/2 hr. within 12 hr., continuing at latter rate with minor fluctuations for the remainder of the study period and resulting in an average excretion of approximately 3.5 mg. F/day. Still other industrial employees, studied less extensively, showed urinary F concentrations before and after exposure which were consistent with the findings of the experimental work.

554. Cummins, C.J., Dunn, T.L., Rayner, H.E.G. and Sullivan, J.L.: An Investigation into the Health of 625 Employees Engaged in Gas Production in New South Wales. Department of Public Health, Division of Industrial Hygiene, New South Wales, Australia, 1952, pp. 43.

The survey reported here was carried out by the Department of Public Health and arose out of the Royal Commission of Inquiry into the Gas Industry held in Sydney in 1948. Six representative units engaged in gas production in New South Wales, i.e., in Sydney as well as in the country areas, were investigated with a view to determining the type and extent of medical hazards existing in the industry and their effects on the general health of the exposed persons. Emphasis was directed towards dust inhalation, contact with CO, exposure to high temperatures and climatic extremes and the dermatogenic effects of the handling of tar and tar products. 625 volunteers, engaged directly or indirectly in gas production, were examined medically, representing 82.78% of the total employed in the units surveyed and comprising about 62% of all those engaged in gas production in this State. The age in the various groups ranged up to 64 yr., the age distribution showing a pronounced deviation towards the older age groups. 61% of the workers examined were 40 yr. old and above, 35% were over 50 yr., whereas the number with 10 yr. or less of exposure constituted 53% of those investigated. The occupations encountered in this survey are classified as belonging to one of 6 groups: coal transport, carbonization and retorting of coal, manufacture of carburetted water and oil gases, coke disposal, purification of coal gas and manufacture of by-products. The main potential hazards were: dust exposure (coke or coal, siliceous dust, FeO); noxious gases and fumes (CO, SO_2, H_2S, tar fumes, Pb); physical and environmental factors (heat and humidity, climatic variations, moisture, noise) and specific dermatogens (tar products). With the possible exception of an increased

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Cummins, C.J. et al. (continued)
tendency to chronic bronchitis in the persons exposed to dust, the general health of the total group examined was comparable to any similar group. The incidence of pneumoconiosis was low and confined to those in contact with highly siliceous material. The present degree of exposure to "refractory" dust was within limits generally accepted as safe in this State. The trend to increased incidence of chronic bronchitis was dependent neither on exposure to any particular dust nor on exposure to climatic extremes. There was no evidence of any increased incidence of skin disease associated with contact with dust. Since the exposure to CO under normal conditions, was<100 ppm and always occurred intermittently, there was no evidence of chronic CO poisoning or any residual ill-effects from constant inhalation of small concentrations of CO. Due to acclimatization and low exposure periods, there were no observable clinical effects resulting from the exposure to high temperatures and climatic extremes: no increased incidence of either acute respiratory or acute or chronic rheumatic diseases. As to changes attributable to the action of tar products, one case of tar epithelioma was detected. The same occupational group also contained several cases of black hyperkeratoses on the dorsum of the hands. 9 appendices.

555. Davies, C.N.: Dust sampling and lung disease. Brit. J. Ind. Med. 9:120-6, 1952.

Selective dust sampling, in which only fine particles are collected, often offers better prospects of correlation with the incidence of disease than the assessment of total concentration by weight, because the coarser particles are deposited in the higher bronchial tubes, from which they are excreted, while only small sizes reach the alveoli. The application of this principle is discussed in relation to the nature of the air-borne dust. With a view to defining a suitable acceptance curve for sampling apparatus, recent work on the retention of dust in the human alveoli is examined. For particles of unit density, the maximum alveolar retention is between 50% and 60% of the dust inhaled and occurs between 1.5μ and 2μ diameter; about 30% of the 5μ particles are retained. It is possible that when coal dust is inhaled the proportion which is retained in the alveoli is greater than in the case of quartz of rock dust. Minimum alveolar retention occurs at 0.25-0.3μ, smaller particles being more completely deposited. Alveolar retention from 0.3μ to 2μ diameter depends on the ratio of tidal air to frequency of respiration and does not change rapidly with rate of working; upper lung retention varies with minute volume, however, and is therefore sensitive to muscular activity. Selection of particles for sampling by an elutriator designed to accept 50% at 5μ diameter (unit density) should give a good approach to an alveolar sample. Variation of the density or shape of the particles will affect alveolar retention and elutriation in the same way, since both depend on the sedimentation rate of the particles, so that a single selector will give a constant performance with all clouds.

556. Doll, R.: The causes of death among gas-workers with special reference to cancer of the lung. Brit. J. Ind. Med. 9:180-5, 1952.

This investigation is an entirely statistical one in which the mortality rates experienced by male pensioners of a large London gas company are compared with those of the male population of Greater London. The methods of statistical procedure followed are explained and included a weighting factor applied to rates for England and Wales to obtain the rates for Greater London. Among the pensioners, there were 840 deaths against 856

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Doll, R. (continued)
which could have been expected. This would indicate that the pensioners' group was a fair sampling population. Individual causes of death (or groups of causes) showed no appreciable difference from the expected numbers with the exception of lung cancer; 25 deaths were attributed to lung cancer against 13.8 expected ($P<0.01$). The investigation enables the conclusion to be drawn with some confidence that gasworkers suffer a disproportionately heavy mortality from cancer of the lung. Indeed, in the group the mortality from cancer of the lung was 181% of the mortality which, it was estimated, would have been suffered by a comparable group of Londoners, and 240% of the mortality calculated for a comparable group representative of all England and Wales. Some cases of cancer of the lung must be expected to occur among gasworkers due to causes common to the whole population, e.g., tobacco smoking, but not this excess. The carcinogenic properties of gas tar suggest themselves as the determining cause; but evidence concerning the exact occupational exposure of the cancer cases was not sufficiently accurate to enable this to be tested. But the excess mortality from lung cancer occurred principally among employees engaged on the production of gas and on the treatment of waste products (17 observed deaths to 8.6 expected), rather than among the workers concerned with gas distribution (8 observed against 5.2 expected).

557. Eisenbud, M.: Retention, distribution and elimination of inhaled particulates. Arch. Ind. Hyg. and Occupational Med. 6:214-25, 1952.

The deposition of particulates within the respiratory system occurs in 1 or more of the following ways. (1) Inertial impaction: Important in the nasal airways and in the upper lung, where the air is moving at relatively high velocity and particles may be impacted on the mucoid bronchial lining by sudden changes in direction of the air stream. The larger particles are more likely to be separated in this way; the inertial effect = kpd^2 (p=density, d=diameter). (2) Sedimentation: More important in the deeper portions of the lung (passageways minute and air velocities reduced). Again more massive particles are favored. (3) Brownian motion: There is little air movement within the alveolar spaces of the lung so that Brownian motion seems to be the mechanism to effect deposition for particles too small to be effected by gravitational settling. In reviewing the work on retention and particle size of the various investigators, the author comes to the following conclusions. For nasal breathing, deposition within the alveolar structure of the lung is maximum in the range of 1-30μ. Large particles tend to be deposited in the upper respiratory passages. Deposition diminishes with decreasing particle size to 0.1μ, below which it has been shown that Brownian motion tends again to increase deposition. For mouth breathing, deposition within the alveolar portion of the lung is minimum at about 0.5μ and increases for both smaller and larger particle sizes. Large particles (>5μ), though few in number, are possibly of importance in relation to radiologic risk from α-emitters because of the relatively small volume of tissue in which the radiations are absorbed. The radiation from a 10μ α-emitter is absorbed in 1/1000th of the tissue volume that absorbs the equivalent energy delivered by 1μ particles of similar specific activity. Particles in the range of maximum retention for nasal breathing (1-3μ) comprise the largest portion, by weight, of the particle-size spectra of the aerosols most commonly encountered. Dust may be removed from the respiratory tract by phagocytosis, ciliary action or by its solubility in lung fluid. Which factor operates depends upon the nature and size of the particle. A table and graph summarizing the work of the various investigators on this subject are given.

558. Landahl, H.D., Tracewell, T.N. and Lassen, W.H.: Retention of airborne particulates in the human lung: III. Arch. Ind. Hyg. and Occupational Med. 6:508-11, 1952.

Two human subjects inhaled through the mouth at 60 l/min. air containing droplets of triphenyl phosphate, 0.1-6.3μ in size. The patterns of respiration were rigidly controlled. The relative concentrations of various size particles in each of 4 fractions of expired air are tabulated for 4 and 8 sec. cycles breathing rate. This shows minimum retention occurring for 0.25 and 0.55 μ size particles. The results are also graphed. Retention values are, in general, larger than at a flow rate of 18 l/min. as was expected.

Experiments were run in which the average time (H) spent by an air sample in the lungs was varied at 3, 6 and 9 sec. and inspiration (I) and expiration (E) times were held equal at 3 sec. 0.55μ particles were inhaled at a rate of 60 l/min. Mean time (T) in lung varied at 6, 9 and 12 sec., being calculated as $\bar{T} = I/2 + H + E/2$, and was plotted against % retention in lungs. The observed % retention was found to increase from about 20-60% as the mean time in the lungs increased from 2-12 sec., and the values compared favorably with calculated values for the corresponding breathing patterns.

559. Mellon Institute of Industrial Research (T.F. Hatch, Principal Investigator): Final Report of Research carried out for The Chemical Corps Biological Laboratories, Camp Detrick, Maryland on Contract No. DA-18-064-CML-1652, Mellon Institute Fellowship No. 333-3, For the Year August 16, 1951 through August 15, 1952, 44 pp.

The method and calculations used whereby upper respiratory and alveolar dust retention is determined by separation of the total volume of expired air into the upper respiratory and lung air which, in turn, is determined from the CO_2 content of partitioned expired air are discussed. The CO_2 concentration in the forced exhalation sample, which is taken to represent effective lung air, provides the basis for calculating alveolar dust retention. Dust retention is shown to vary with the square of particle size in both the alveolar and upper respiratory tracts. As breathing frequency is decreased over-all retention (R) increases, alveolar retention (A) is slightly increased, upper respiratory retention (U) is not materially affected and percentage alveolar deposition (AP) of the total inhaled particles is increased.

The effect of a bronchodilator (viz., isuprel· HCl) on dust retention, using china clay dust of 1.24-1.8μ, was measured on 2 subjects. No significant differences were noted between dilator and nondilator tests.

The comparative effects of standing and supine position upon dust retention was studied on 2 subjects. The resulting data, including % CO_2 in each portion of the exhaled air, cc. CO_2/breath, tidal volume (TV), physiological dead space, effective lung volume/TV (K), R, U, A and AP, are tabulated. From this, it is concluded that dust retention with passive breathing in the mechanical respirator does not differ significantly from the retention with voluntary respiration, and the change in respiration (increase in TV and in min.-vol.) when the subject is in a standing compared with supine position, does not alter dust retention significantly. This is true for R, U, A and AP.

Dust retention in animals is next discussed. The partitioning valve and the respirator used in monkey experiments are described in detail. 4 tests to determine the CO_2 patterns of monkeys were made on 1 animal and gave % CO_2 values in the 3 portions of exhaled air that were similar to those obtained on humans.

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Mellon Institute of Industrial Research (continued)

Guinea pigs were exposed to particles of Sb_2O_3, 1-1.25μ in size and 5.67 density. These are dynamically equivalent to 1.5μ clay particles (density-2.65). Compared with human retention values for 1.5μ clay particles, the over-all retention is in rather good agreement; for man R=70%. U is considerably higher, but A is lower than the values reported for man. (Brown, J.H., et al.: Am. J. Public Health 40:450-9, 1950.) The effect on A is probably due to a greater breathing frequency. 4 guinea pigs were exposed for 10-min. periods to clay particles; the results are tabulated. They show a variation among the individual animals, but unusually good agreement in the values for each animal. 5 guinea pigs were exposed to 0.337μ C particles and the results tabulated. Compared to human tests, R is about the same as for humans, U is ca. 10% greater and A ca. 10% lower in the guinea pig than in the human.

560. Oldham, P.D. and Roach, S.A.: A sampling procedure for measuring industrial dust exposure. Brit. J. Ind. Med. 9:112-9, 1952.

In any method of estimating the dust exposure of workmen for correlation with the incidence of pneumoconiosis, the men at risk must be sampled, the duration of exposure, as well as dust concentration, must be measured, and the effects of variability of exposure in duration and intensity must be taken into account. Evidence is produced showing the errors that can arise from ignoring these criteria, and a new method of dust sampling which satisfies them is described. This method is based on following individual workmen with a sampling instrument throughout their working day; these workmen are chosen by a random principle from all those on whom the incidence of disease is to be measured. A practical example is given and the results tabulated. The method is demonstrated to be simple and economical.

561. Williams, N.: Vanadium poisoning from cleaning oil-fired boilers. Brit. J. Ind. Med. 9:50-5, 1952.

Eight men engaged in oil-fired boiler cleaning displayed symptoms of V poisoning, viz., watering of the eyes, soreness of the throat and behind the sternum, rhinorrhoea and sneezing. These symptoms occurred 1/2-1 hr. after starting work, but in some cases not until 12 days later. The secondary symptoms occurred in 6-24 hr. and consisted of dry cough, wheezing, severe dyspnea, lassitude and depression. A greenish-black coating of the tongue developed; this disappeared 2-3 da. after cessation of exposure to the petroleum soot as did most of the other symptoms. No permanent ill-effects were noticed. Analysis of the atmospheric dusts in the various boiler chambers for V gave the following results.

Chamber	dust (mg./m.^{3} air)	Vanadium (as % of dust)	Vanadium (mg./m.^{3} air)
superheater	659	6.1	40.2
superheater	239	7.2	17.2
combustion	489	12.7	58.6

562. Amdur, M.O., Melvin, W.W., Jr. and Drinker, P.: Effects of inhalation of sulphur dioxide by man. Lancet 2:758-9, 1953.

Fourteen healthy men, aged 28-58, breathed SO_2 in concentrations varying from 1-8 ppm, through a face mask while resting. The volume of expired air was measured in a spirometer, and the respiratory rate and pattern were measured by a pneumotachograph. Concentrations of 1-2 ppm were not usually detected. At 5 ppm most people complained of a slight feeling of dryness in the throat and upper respiratory passages, but could not actually

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"smell" it. Those exposed to 6-8 ppm definitely detected SO_2 in the air but became accustomed to it as the exposure increased. For each of the concentrations (1-8 ppm) tidal volume decreased, respiratory rate increased and pulse rate increased in the same general pattern. Graphs showing these changes for SO_2 concentrations at 1 ppm and at 5 ppm are given. 2 men who worked daily in atmospheres containing $\geqq$10 ppm SO_2 showed no changes when exposed to 5 ppm. The pneumotachographic tracings and a graph of total volume, respiration rate and pulse rate vs. minutes are given. No persons with pre-existing respiratory or cardiac disease were studied.

563. Cummins, C.J. and Rayner, H.E.G.: An Investigation into the Health Hazards in Gas Distribution in Sydney. Department of Public Health, Division of Industrial Hygiene, New South Wales, Australia, 1953, 16 pp.

A survey of the industrial processes in the distribution of commercial gas has been carried out to determine the type and extent of the medical hazard existing in this branch of the gas industry and the effects of such hazards on the general health of those engaged in the industry. The principal and only major hazard was from inhalation of CO. The possibility of acute gassing is well recognized by the industry and is greatest in the occupations where work has to be carried out on live gas lines. The occupations most exposed to this risk are the service layers (700-1,000 ppm CO) and certain members of the mains gangs such as governor attendants (concentrations of CO in shallow pits, 36-700 ppm; in underground pits: inside, 2-3%, at street level, 1,000 ppm). This latter group is provided with personal protective devices by all companies, but only the service layers of one company are issued personally with respirators. 379 employees of the 3 metropolitan gas companies were examined. In addition to thorough medical examinations, detailed general, medical and industrial histories were taken. The examined workers ranged in mean age of their respective age groups from 35.3 ± 0.8 to 59.6 ± 0.9 yr., and their exposure up to 30+ yr. No sequelae from previous attacks of acute or subacute CO poisoning were found. Although in the industry investigated, there is potential and actual repeated exposure of certain occupations to concentrations of CO greater than those accepted as safe working practice, the author found no syndrome or physiological changes which could be attributed to chronic exposure to CO. However, in the workers examined, there were high blood pressure readings throughout, and there was a definite increase in the age specific mean blood pressures when compared with those of other industrial groups. This was more marked in the age groups between 40 and 65 yr. The mean blood pressure of that section of the survey group most exposed to CO was not significantly higher than for the section with minimal exposure to CO (mean systolic blood pressures: for the former group, 141.9±2.2 mm. Hg; for the group with minimal exposure, 139.8±1.2 mm. Hg). According to the author, the increase in mean blood pressures from the age of 40 is a reflection of the incidence of arteriosclerotic-hypertensive disease in these age groups, a trend which had been noted in other industrial occupations, particularly in the U.S. Although the incidence of this type of disease was higher than that reported in Australian industrial groups, it was comparable with the incidence in various industrial groups in the U.S. The author doubts that occupational factors have had any influence on this rate in the group of workers examined in the course of the survey. The general standard of health was good. The incidence of diseases of all systems other than the cardiovascular system is given in numerous appendices.

564. Dervillée, P., L'Épée, P., Campaignolle and Lazarini, H.J.: Quelques cas de cancers du brai d'évolution aiguë. (Some cases of acute cancer due to tar.) Arch. maladies profess. méd. travail et securité sociale 14:271-2, 1953.

The cancer observed in the clinical cases reported in this paper appeared spontaneously, without previous trauma or burning, as it is frequently seen in workers handling oil tar, and without the occurrence of precancerous lesions, in 4 workers who had never had any skin lesions before. The ages of the examined workers ranged from 31 to 57 yr., the exposure periods from 5 to 22 yr. Case 1 was a worker who within 3 wk. developed a projecting lesion of half a pea size on the left lower eyelid, the center of which was verrucous while the peripheral regions were red and swollen. The lesion was indurated, sensitive on pressure and surrounded by an erythema, 0.5 cm. in diameter. Otherwise, the facial skin was normal. Biopsy revealed that the lesion was an epithelioma, spinocellular in nature and containing voluminous trabecula, malpighian cells and keratohyalin granulations in the neoplastic tissue. There was an abundant infiltration of both mono- and polynuclear cells in the connective tissue. Amidst some trabeculae, there were sebaceous cellules indicating the possibility of a glandular origin of the tumors. Case 2 is described of a worker who, within 4 wk., developed on the right cheekbone a lentil-size, slightly projecting, indurated lesion with verrucous center, surrounded by a ring of epidermis imbedding the hyperkeratotic center. The lesion was neither painful nor red; the other facial skin was normal. Biopsy confirmed the diagnosis of spinocellular epithelioma. Case 3 concerned a worker who, within 3 wk., developed an indurated lesion of the size of a small pea, with dry, irregular surface which was hyperkeratotic. This lesion was located on the philtrum at mid distance between the pink border of the lip and nostrils. There were neither pain or signs of inflammation. Biopsy showed that this lesion, too, was an epithelioma of spinocellular nature. The worker described as Case 4 developed within 10 da. a verrucous, lenticular lesion on his upper lip which was shown on biopsy to be a spinocellular epithelioma. All 4 epitheliomata could be cured with diathermocoagulation.

565. Karsch, J.: Die Keratokonjunctivitis chemicalis in den Sächsischen Kunstseidenwerken Pirna. (Chemical keratoconjunctivitis in rayon (artificial silk) industry in Pirna (Saxony).) Klin. Monatsbl. Augenheilk. 122:440-9, 1953.

The increasing incidence of an eye disorder in workers in German rayon industry is reflected in the statistical data collected in one plant under various conditions and covering the year from Nov. 1950-51. They show the following maximum monthly and daily incidence, respectively: monthly average, 71.6; maximum, 145; minimum, 16; median, 78; daily average, 11.6; maximum, 30; minimum, 3; median, 10. A description of both working processes and conditions demonstrates that the workers in the spinning room developed this disease which they called "spinner's disease." The ventilation and the fresh air supply of the spinning room often were unsatisfactory, and air samples collected on one day in various parts of the spinning room showed the presence of H_2S at concentrations varying from 9.16 to 34.82 mg./m.^{3} air. In addition, considerable amounts of CS_2 (no concentrations given) entered the room with the warm exhaust gases from the washing rooms. It is stated that, according to numerous publications, the incidence of the eye disease has frequently been observed in connection with exposure to H_2S. The MTC for H_2S is established at <20 mg./m.^{3} air = 15

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ppm; the safe concentration is given as <10 mg./m.^{3} air. In guinea pigs and rabbits, the exposure to H_2S in the air at a concentration of 50-100 mg./m.^{3} had not produced any changes, but a mixture of H_2S and CS_2 at 70 mg./m.^{3} had markedly affected the cornea of the animals. CS_2 had a drying effect and influenced the threshold concentration. The clinical picture of the keratoconjunctivitis with regard to subjective signs is characterized as follows: a sensation of intraocular pressure, an intense piercing and burning pain, photophobia, the appearance of colored rings around the lights or, in daylight, the sensation of looking through a veil, extensive lacrimation and severe rhinitis with abundant watery secretion. The clinical symptoms found on examination were: conjunctivitis, edema of the eyelids, marked pericorneal injection of the eyeball, blepharism, slight miosis and corneal opacity due to band-shaped and stippled epithelial defects. The fundus oculi was not affected. Typically, only the palpebral fissure was injured, and the effects were noted only on contact with fresh air, sometimes not until the next morning. When treated properly, the described symptoms disappear within 4 da. Most likely, H_2S paralyzes the respiratory cell oxidation. The lacrimation does not influence the effects caused by the gas. The injurious action of H_2S is completely independent from the meteorologic conditions and is in no way modified by the weather situation. Treatment and prophylaxis of the keratoconjunctivitis are discussed, and the importance of proper ventilation in the spinning rooms of rayon plants or wherever there is an exposure to H_2S is pointed out.

566. Ohno, S.: (Comparison of toxicity of sulfur dioxide and ammonia.) Igaku Kenkyuu 23:1258-64, 1953.

On the basis of both his own and other investigators' experimental work, the author first discusses acute as well as chronic SO_2 and NH_3 poisoning and then compares the toxicity of both gases by means of the "fatality product" (concentration of the gas in % duration of exposure in min.) per body weight of animal (in kg.). No further details on the experiments are given in the summary. Exposure to SO_2 and NH_3 causes irritations of the mucosae, especially of the eyes; at higher concentrations, bronchitis, hyperemia, hemorrhages, edema, exudation and pneumonia are the characteristic respiratory symptoms produced. In severe cases of poisoning due to both gases, acidosis is frequently observed. Calculation of the "fatality product" for both gases demonstrated that the toxicity of SO_2 is several times stronger than that of NH_3. (Mainly author's summary.)

567. Pinto, S.S. and McGill, C.M.: Arsenic trioxide exposure in industry. Ind. Med. Surg. 22:281-7, 1953.

A study of the effect of exposure to As_2O_3 dust on the workers in a smelter was carried out. It was concluded that the deleterious effects of such exposure are principally irritation of body surfaces exposed to direct contact with the dust, viz., the exposed skin, conjunctivae and mucous membranes of the nose. Systemic poisoning by inhalation of As_2O_3 dust alone is rare. The average urinary As value found in 147 determinations made on 124 normal individuals not exposed to As_2O_3 dust was 0.13 mg.As/l. 835 urinary As determinations were done on 348 men exposed to As_2O_3 dust. The urinary As values ranged from 0.10-6.44 mg.As/l. of urine. 95% of the exposed group had less than 2.1 mg. As/l. of urine. The average urinary As excretion value for the entire group was 0.82 mg./l. of urine. In 16 individuals, urinary As determinations were made on each sample of urine passed for periods of 2-5 da. Each individual had been exposed to

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inhalation of As_2O_3 and was receiving dimercaptopropanol (BAL) therapeutically for dermatitis. The rate of As excretion was found to be 0.7 mg.As/24-hr. period. Moderate cigarette smoking did not increase the amount of As found in urine. "In this study we did not find a urinary As level consistent with disease. These data indicate that much more As can go through the human body without causing sickness than has heretofore been realized."

568. Asset, G. and Pury, D.: Deposition of wind-borne particles on human skin. Arch. Ind. Hyg. and Occupational Med. 9:273-83, 1954.

Deposition of spherical organic particles on 2 types of surfaces, the forearm of human subjects, with glass cylinders, 7.5 cm. in diameter, for comparison, was studied. A wind tunnel was used for the exposures. It was so designed as to produce uniform velocity, parallel in direction to the length of the tunnel, so that the particles (mass median diameter (MMD) 1.3 and 6.5 μ) were borne by constant, horizontal winds of low velocities to the objects from a distant source. The aerosol used was triphenyl phosphate. Particle size was measured by means of a Casella cascade impactor. Samplers were placed 2-3 in. above the objects tested so that the plane of sampling was the same as the plane of exposure. Isokinetic sampling was used, which insured that the flow lines of the sampler would remain undisturbed. Wind velocity was measured with a Hastings Precision Air Meter. Chemical analysis of triphenyl phosphate was made in which intensity of color was read on a Klett-Summerson Colorimeter. The theory of inertial impaction and the nomenclature used is explained in detail.

Exposures were made on the forearms of 9 different male subjects at wind speed 2 and 5 mph, with time of exposure varying from 10-30 min. The arms were placed in the tunnel so that the flat parts faced toward the wind, with the radial side up and ulnar side down. In most runs, the hairy extensor surface faced upwind, but in a few, the hairless side was exposed to the wind. Recovery of the deposited aerosol was made by washing an area of 10 $cm.^2$ which had been near the axis of the tunnel during exposure. No deposition was found on the glass cylinder after 20 min. exposure at area doses 446-1,410 $mmg./cm.^2$ (the dosages are listed according to $\underline{K} = 1.8 \times 10^{-3}$ and $\underline{K} = 4.6 \times 10^{-3}$, where $\underline{K}$ is the impaction parameter).

Exposure of hairy surface of forearm to aerosol of MMD 6.5μ at doses of 443-1,470 $mmg./cm.^2$ facing upwind (velocity 5 mph) resulted in significant deposition, up to 11.3 $mmg./cm.^2$ after 30 min. exposure. The deposit on the hairless surface was significantly less; it occurred at higher concentrations, but was not detectable at the lower. The minimum detectable amount on the arm was 1.0 $mmg./cm.^2$. Comparison of particle size and wind velocity on the efficiency of deposition after 20 min. exposure, shows that both factors increase this efficiency. The efficiency of deposition was less on the downwind side of the arm than on the upwind.

569. Breslow, L., Hoaglin, L., Rasmussen, G. and Abrams, H.K.: Occupations and cigarette smoking as factors in lung cancer. Am. J. Public Health 44:171-81, 1954.

518 patients with lung cancer were observed during 1949-52 in 11 Calif. hospitals in order to determine a relationship between lung cancer and smoking and type of occupation. For every 1 of these cases another patient with a condition other than cancer or a chest disease admitted about the same time and of the same age (within 5 yr.), sex and race was chosen as a "control." The statistics on smoking include incidence of lung cancer in relation to amount of smoking, age of beginning cigarette smoking, smoking habits and "cigarette cough." The data suggest that smoking and several

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Breslow, L., et al. (continued)
occupations, i.e., welders, steam fitters, boilermakers, asbestos workers, electric bridge crane operators, extracting Pb, Zn and Cu ore, marine engineers, firemen, oilers and wipers, construction and maintenance painters and commercial cooks, may be involved in the development of lung cancer.

570. Dechoux, J.: La Pneumoconiose des Mineurs de Fer du Bassin de Lorraine. (Pneumoconiosis in Iron Ore Miners in the Lorraine Basin.) Nancy, Imprimerie Georges Thomas, 1954, 170 pp.

In a study of the incidence of pneumoconiosis in Fe miners in Lorraine, a total of 361 persons were found to have pulmonary X-ray patterns indicative of or suggesting pneumoconiotic changes. In 267 of them, the diagnosis of pneumoconiosis was established, and of these, 126 miners were subjected to detailed clinical examinations, with emphasis on X-ray findings as well as on examination of the pulmonary function in most of them. The following lung function studies were carried out: spirographic and pharmacodynamic tests, measurements of both residual volume and arteriel O_2 saturation and, in addition, testing of the pulmonary functions on exercise. Furthermore, examinations of the cardiovascular system and bronchoscopic as well as bacilloscopic studies were done.

All test methods and the results obtained are described in detail. In conclusion, the author states that to date in France, the only pneumoconioses acknowledged as occupational diseases are silicosis and asbestosis. However, the results obtained during the investigation reported here demonstrate that in cases of pneumoconiosis, there frequently is considerable disproportion between X-ray changes and actual impairment of pulmonary function. An accurate evaluation of the clinical picture in cases of pneumoconiosis is possible only by thorough study of pulmonary functions, in addition to the medical, especially radiologic examinations.

571. Fallentin, B. and Frost, J.: Sundhedsfaren ved rensning of oliefyrede kedler stammende fra vanadium og svovlsyre i soden. (Health hazards from cleaning oil-fired boilers caused by vanadium and sulfuric acid in the soot.) Nord. Hyg. Tidksr. Nos. 3/4:58-65, 1954.

In 1950 some boiler cleaners were referred to the clinic on account of conjunctivitis and respiratory symptoms after cleaning oil-fired boilers. Mild, or severer, irritation of the mucous membranes was a usual occurrence during and after this work. In some cases coughing persisted for several wk., accompanied by slight fever. The soot from the boilers was analyzed and showed a high V content. As V, especially in the form of pentoxide, V_2O_5, is known to cause such symptoms, the poisoning was ascribed to V. 5 cases of chimney sweeps in Norway involving skin irritation and burns from cleaning oil-fired boilers had been described just before this. This soot contained 20% sulfates with a pH of 2.2; no analysis for V was made. 8 cases of V intoxication from cleaning oil-fired boilers in a generator station in England were also described at that time. The soot was analyzed for V, but pH was not determined. A series of samples of soot, mainly from oil-fired boilers, but also from other fuel-fired boilers, were analyzed by the authors. Soot from oil-fired boilers contains V, especially when heavy fuel oil is used. A low pH (ca. 1-2) is found in the presence of even a small % of V. Soot from coke and coal or a mixture with a low % of oil contains no V and gives a neutral or slightly acid or alkaline reaction. The explanation of the greater amount of SO_4= found in the soot from oil-fired boilers, though coke and coal contain as much S, probably is that V acts as a catalyst for the formation of SO_3 in the flue

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gas. Temperature in the furnace is also another factor. The boiler cleaners' symptoms therefore are probably due to both the V and the acid-reacting dust. Probably the more delayed and prolonged symptoms are due to the V, and the more immediately occurring symptoms are caused by the H_2SO_4. Appropriate precautions to be observed during the cleaning of oil-fire boilers were instituted. (Abstract of authors' summary.)

572. Greenwald, I.: Effects of inhalation of low concentrations of sulfur dioxide upon man and other mammals. Arch. Ind. Hyg. and Occupational Med. 10:455-75, 1954.

The reports of the therapeutic use of SO_2, through the ages, particularly in treatment of skin diseases, on both man and animals are reviewed; these reports tell of very few harmful effects of SO_2. The early reports of damage due to industrial exposures to SO_2 and H_2SO_4 are next discussed. An excellent review is given on the experimental studies of the effects of the inhalation of low concentrations of SO_2 and H_2SO_4 on man and animals and the important facts, i.e., observer and date, species, concentration, time of exposure and effects, are tabulated for each substance. The following conclusions are stated by the author. The various species and even individuals differ greatly in susceptibility; rats are the most resistant to SO_2, while rabbits are the most resistant to H_2SO_4, then rats, mice and guinea pigs. Man is much more sensitive than any of these animals to both SO_2 and H_2SO_4. Young guinea pigs (1-2 mo.) are much more sensitive to mists of H_2SO_4 than are mature animals (1 1/2 yr.) Continued exposure of animals to high concentrations (100 and 500 ppm) of SO_2 lowered their resistance to infection with a variety of microorganisms and lessened the formation of antibodies. Similar exposures to 50 ppm had no such effect. Concentrations of SO_2 at 1 ppm and of H_2SO_4 at 0.5 mg./m.^{3} are not detected by human beings but do alter the respiratory pattern. Very few healthy adults find concentrations of SO_2 up to 5 ppm or of H_2SO_4 at ca. 1 mg./m.^{3} objectionable. Concentrations twice as great are apt to be irritating. The present maximum allowable concentration of 10 ppm of SO_2 is regarded as probably excessive for prolonged exposure,also, since it is not based on direct evidence. There is no good evidence that either chronic exposure to concentrations below 5 ppm of SO_2 or occasional exposure to higher concentrations, so long as these are not overpowering, have any ill effect upon healthy men. The possible injurious action of these or of even lower concentrations upon young children, upon the aged and upon those afflicted with circulatory or respiratory disturbances requires investigation. The possibility that such persons are adversely affected by simple fog should be investigated, if possible. Adequate statistics might be available from Brighton, England. The possible modifying action of other contaminants, particularly aerosols and dusts, should be investigated more thoroughly. SO_2 and H_2SO_4 can neither be held responsible for the Meuse Valley, Donora and London episodes nor be absolved from at least partial responsibility for them.

A brief review of methods of analysis is also included. (79 refs.)

573. Letterer, E.: Über Lungenverstaubung durch Marschstrassenstaub. Akute Silikopneumokoniose. (Dust lung caused by marching. Acute silicopneumoconiosis.) Beitr. Klin. Tuberk. 3:501-9, 1954.

The patient in question was a 47-yr. old colonel in the German army. During the campaign in the Caucasus, he had been exposed for several weeks to "inconceivable amounts" of very fine siliceous dust, and subsequently had developed a chronic interstitial pneumonia. 5 mo. after the onset of

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the disease and 2 mo. after admission to a hospital, following an apparent improvement of about 4 wk., a supervenient bronchopneumonia led to his death. His anamnesis showed no serious diseases other than chronic bronchitis and icterus. On admission to the hospital, the examination revealed mainly these symptoms: general fatigue, anorexia, weight loss (20 kg. within a yr.), dyspnea and cough. There was neither radiological nor bacteriological evidence of t.b. The X-ray showed shadows on the lower and middle pulmonary lobes. An autopsy was performed, and the findings of both macroscopic and microscopic examinations are reported. Chemical analysis revealed that 8.06 % SiO_2 was present in the ash of the lungs.

Although the described pneumoconiosis as well as the typical silicosis -which is mostly of occupational origin- are both caused by the inhalation of siliceous dust, there are great differences in the clinical pictures. The typical silicosis is usually characterized by the formation of silicotic lesions in the upper pulmonary lobes and a chronic course, and generally follows the long-term exposure to inhalation of smaller or moderate amounts of siliceous dust consisting of larger particles. However, short-term exposure to inhalation of great quantities of very fine siliceous dust, as in the case described in this report, causes a pneumoconiosis with a clinical picture comparable to asbestosis. As an explanation for these variations, the author points out that the duration of exposure, the physical and chemical properties of the inhaled dust, the individual predisposition and the differences in resistance and in reaction of the individual organisms have a great modifying influence on the effects caused by dust inhalations.

Consequently, reservation is indicated in concluding from the experience gained from the observation of one clinical case as to the effects the same conditions might have on other patients; to the author, the fact that the dust from a sandy road may cause organic pulmonary disturbances seems to be noteworthy. (This is a single case only, with no indication that other cases might have occurred. Yet it is entirely logical to assume that many others were exposed to the same environmental conditions. What happened to the others? The X-ray was apparently not typical of silicosis. It was typical of pneumonia, however, there is no evidence that there was any true exposure to free, uncombined silica (SiO_2) which is the etiologic agent of silicosis.

The only item in the report that appears to show a causal relationship is the finding of 8.06% SiO_2 in the ashed lung. This merely indicates that the person had inhaled silica dust - it does not indicate how much or when - nor does it have any relationship to tissue abnormality. FP.)

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574. Randolph, T.G.: Allergic type reactions to industrial solvents and liquid fuels. J. Lab. Clin. Med. 44:910 (Proc.), 1954.

The fumes of various petro-, chloro- and/or sulfo-chemicals produced in the area of NW Indiana irritate allergic individuals particularly by either inciting localized or constitutional hypersensitivity-type reactions in their own right or by augmenting some basic mechanism responsible for these manifestations. Inhalation of the fumes of fresh paint, gasoline, or kerosene, refinery areas, fresh newsprint and rubbing alcohol were found to be precipitating causes of allergic type manifestations, respectively, in 74, 61, 60, 51 and 25 of 80 selected individuals having high degrees of clinical intolerance to a wide range of petroleum and coal derivatives and related substances. Intolerance to evaporating paint may be related either to natural or organic solvents, as turpentine, pine oil, cedar fumes and evergreen Christmas decorations are a few of the pine products producing clinically similar effects. Exposures to evaporating

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Randolph, T.G. (continued)
solvents from adhesives, plastics and synthetic rubber are also important. Finally persons of various ordinary occupations are associated with the handling of solvents and fuels involving contactant, inhalant, ingestant or injectant routes of exposure. (Condensed author's abstract.)

575. Schwendiman, L.C.: An application of fluorescent pigment to the measurement of particle inhalation probabilities. U.S. Atomic Energy Comm. Doc. HW-32292, 18 pp, 1954.

ZnS powder with a median diameter of ca. 2µ was used to determine the probability of a single radioactive particle being transferred to the air and breathed in several operations involving operation and maintenance of sedans and busses. A known number of particles were deposited with soil normally present, then the operation giving rise to a potential exposure performed. The number of ZnS particles found on respirators worn or collected on filters used to sample the air during the operation was determined using a microscope and UV illumination. The probability of breathing a single particle when present was found to range from 6×10^{-7}/hr. for driving with minimum air turbulence in the vehicle, to 6×10^{-4}/hr. for sweeping the dirt from a bus. Other operations and probabilities are discussed. (Author's summary.)

576. Seifert, P.: Arsenbefunde bei klinisch-manifesten Arsen-Vergiftungen. (Arsenic values in clinically manifest arsenic poisoning.) Deut. med. Wochschr. 79:1122-4, 1954.

The author's own method for the determination of As was used in quantitative analyses of blood, urine, hair and nails of a) normal persons, b) patients treated with As-containing medications and c) patients with As poisoning. For a), the following ranges (R) and medians (M) are given (γ % As): in blood, R 0.1-20.0, M 10.0, in urine, R 0.3-24.0, M 1.7; in hair R 3.6-61.5, M 16.1; in nails R8.7-62.5 and M 17.3.

b) The therapeutic application of Fowler's solution causes only negligible increases in the As concentrations of the organs mentioned, unless excessive quantities are taken within a short period of time. In patients treated with arsphenamine ("Salvarsan"), high values, corresponding to those observed in severe As poisoning, were found (maximum values for As, given in γ %): in blood, 350; urine, 1,900; hair, 1,400; in nails, 5,200.

c) If the As concentrations found in hair and nails are within the normal range, the intake of poisonous amounts of As probably has not taken place within 3-8 mo. prior to analysis. If analysis reveals increased As values, the poisoning occurred 2-3 mo. before analysis. Normal values for As concentrations in blood and urine indicate that no poisoning has taken place within the last 2-3 mo., whereas increased As values in blood and urine, accompanied by normal concentrations in hair and nails, give evidence of harmful As intake within 2-3 mo. prior to analysis. The findings typical for As poisoning are illustrated by 4 case reports, including one on poisoning in an infant due to diaplacental transmission after an As intake by the pregnant mother. The maximum values found were (As given as γ %): in blood, 160; in urine, 150; in hair, 1,950; in nails, 1,250.

577. Stokinger, H.E.: Ozone toxicity. A review of the literature through 1953. Arch. Ind. Hyg. and Occupational Med. 9:366-83, 1954.

This review of O_3 discusses its properties, occurrence and preparation, toxicity (acute and chronic effects in animals), human exposure and sources of, and uses of O_3. 61 references are given.

578. Browne, R.C.: Vanadium poisoning from gas turbines. Brit. J. Ind. Med. 12:57-9, 1955.

Twelve cases of V poisoning are described in men working in a gas turbine heat exchanger. The V was in the form of a silicate, vanadate or pentoxide, and formed 11-20% of the deposit on some tubes which the men were cutting away. The symptoms were acute irritation of the respiratory tract, with nose bleeding and blackening of the tongue and teeth. Irritation of the skin and eyes was also reported. The immediate prevention of the condition is by means of waterproof protective clothing and breathing through a mask with an external air supply. Applied chemical engineering may make this job unnecessary in the future. Gas turbines and diesel engines which use residual oil as a fuel will contain in their exhaust 20-60 ppm (by weight) of V silicate or vanadate, which are severe irritants to the human respiratory tract. This may provide a public health problem, but little is yet known about the concentrations concerned. (From author's summary.)

579. Buckup, H.: Eine Pseudotuberkulose durch sich wiederholende Gasvergiftungen. (Pseudotuberculosis due to repeated nitrous gas poisoning.) Arch. Gewerbepathol. Gewerbehyg. 14:98-109, 1955.

Prolonged exposure to the inhalation of nitrous gases may lead to clinically uncharacteristic forms of poisoning which are difficult to diagnose, particularly in the presence of additional complicating or predisposing factors. This is demonstrated in a case report on a patient who, as a miner, had been exposed for 14 yr. to coal dust, after which time he had worked for 15 yr., with 2 yr. interruption, in a nitrogen plant producing 53% and 99% nitric acid from NH_3 gas and fresh air. During the last 3 yr. on the job, he had frequently been treated or hospitalized for several attacks of poisoning following accidental inhalation of greater amounts of nitrous gases. In the course of the last 2 yr., he had developed a chronic condition characterized by productive cough, feeling of oppression, dyspnea, rales, weakness and weight loss of 45 lb. followed by chronic bronchitis and pharyngitis, fever and radiological findings of linear but not focal shadows. The patient temporarily lived with persons suffering from pulmonary tuberculosis and also was exposed to H_2SO_4 and HNO_3 during another 4-mo. period of work after which his condition, exacerbating progressively, forced him to stop working. Analysis of the sputum showed the presence of blood but not of t.b. bacilli, the sedimentation rate rose to 117/125 mm., the blood count showed 13,500 leucocytes. There were considerable auscultatory findings, and the X-ray demonstrated the presence of emphysema, calcifications, densities extending almost over the entire lungs, and also radiant ring shadows increasing in size. 7 yr. after the termination of work, the patient died of cardiovascular insufficiency. The autopsy report and repeated reviews of the series of X-ray pictures, as well as the presence of predisposing factors as cause and effect, are discussed from the standpoint of differential diagnosis, particularly with regard to compensation claim problems. The diagnosis of t.b., expressed on several previous occasions, was ruled out by the autopsy results, which, however, had revealed silicotic nodules, probably resulting from the patient's previous mining activities. In conclusion, the described condition is considered a late effect of repeated poisoning due to nitrous gases, aggravated by insufficient recovery periods as a cause of the war conditions. It is stressed that the resistance of the lungs is lowered unless recovery from the effects of irritant gases is complete before work is resumed.

580. Bugyi, B.: Die Thiopneumokoniosen der Kovandarbeiter. (Thiopneumoconiosis in Kovand workers.) Fortschr. Gebiete Röntgenstrahlen. 83:40-2, 1955.

Reference is made to publications reporting on the incidence of a certain type of pneumoconiosis in Italian workers exposed to S dust during mining which does not occur in workers handling melted S. In order to establish the role of S, if any, in the development of the disease, 9 workers exposed to the inhalation of S dust (no concentrations given) were examined, and chest X-rays were taken. The clinical symptoms found include dyspnea varying in degree of severity, cough and colorless, mucous expectorations. The roentgenological findings are given as follows: infiltrations, peribronchial inflammation and fibrosis, "micronodulation" = pin-point size, round granulations, with sharp contour lines, in the upper lung fields. There was no radiologic evidence of cardiac changes in the patients examined. The author concludes that the incidence of thiopneumoconiosis - as revealed by the study described above - in a plant with excellent hygienic conditions provides new evidence of the hazard associated with the inhalation of S dust.

581. Gilson, J.C. and Hugh-Jones, P., in collaboration with Oldham, P.D. and Meade, F.: Lung Function in Coalworkers' Pneumoconiosis. Med. Res. Council Spec. Rept. Ser. No. 290. London, H.M. Stationery Office, 1955, 266 pp.

After a review of the literature of lung function in pneumoconiosis this report describes a study of 118 South Wales miners in 3 age-groups (35, 45 and 55) and 5 radiological classes, together with 40 normal subjects (aged 25, 35, 45 and 55). Within each age and X-ray group the cases were selected at random from a total of 1,200 films examined, and the authors argue convincingly that these cases provided a representative sample of the general population of miners in these categories. The results are therefore presumably of general application. In this respect the report differs from other functional investigations of pneumoconiosis, nearly all of which have been carried out on persons either attending hospital or applying for compensation, who are preselected with a bias towards disability and complications by other disabling diseases. The design of the experiment allowed separation of the effects of age and radiological stage of the disease upon pulmonary function. 5 cases of nonindustrial emphysema and 2 of pulmonary fibrosis were also included. The subjects were examined clinically and radiologically and underwent a battery of functional tests including measurements of ventilation and arterial O_2 saturation at rest and on exercise, maximum ventilatory capacity, diaphragm movement, lung volume, gas distribution in the lung (by open and closed circuit methods using He as the indicator gas) and CO uptake. The results of all these tests are presented seriatim and are finally subjected to an elaborate process of "factor analysis" which enables a 3-dimensional model to be constructed, showing the interrelation to the test results with one another and with age and X-ray stage. The results are 1st discussed from the point of view of the nature of disability in pneumoconiosis. It is shown that the disability in pneumoconiosis is chiefly due to limitation of ventilatory capacity. There is only a small increase in ventilatory demand on standard exercise either with increasing disease or age, but the best objective indication of breathlessness is the exercise ventilation expressed as a % of the maximum voluntary ventilation. Miners with normal radiographs show a small but significant increase of disability compared with normal controls. Simple pneumoconiosis has a very small additional effect; it accentuates the breathlessness which normally occurs with age, but massive fibrosis (which is associated with superimposed infection,

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Gilson, J.C. et al., (continued)
probably tuberculous) gives increasingly serious dyspnea as it progresses, the effect of which is very important, so that, on the average, younger miners with advanced massive fibrosis are only very slightly more disabled than older men with simple pneumoconiosis. Although the results of tests of gas mixing show quantitative differences between cases of advanced nonindustrial emphysema and pneumoconiosis, the general pattern is not sufficiently distinct for breathlessness due to pneumoconiosis to be distinguished by any tests from that due to nonindustrial emphysema. The implications of these findings for assessments of compensation benefits are discussed and it is suggested that measurement of diaphragm movement might provide a simple objective test of disability, for this is highly correlated with ventilatory capacity. The results do not suggest that focal emphysema is an important cause of disability in simple pneumoconiosis. The last part of the report is concerned with the theory of the distribution and uptake of gases in the lung. These 2 functions were studied simultaneously by combining He and Co in the inspirate and measuring the concentration of both gases in the expirate until equilibrium was reached. A full mathematical analysis leads to the conclusion that gas mixing in the lungs is biphasic even in normal young subjects. This biphasic process is more marked in older subjects and in those with pneumoconiosis, and is extreme in emphysema. It appears that gas absorption is uniform in the 2 parts of the lung responsible for the biphasic mixing in normal subjects, but in both the cases of emphysema and the 2 cases of pulmonary fibrosis there appears to be uneven reduction of gas absorption in the 2 parts. There is a vast amount of information of interest both to industrial medical officers and pulmonary physiologists in this report. It provides the most complete account of the functional disturbances in pneumoconiosis that has ever been published. It is clearly written and illustrated by a large number of excellent diagrams and tables. (Abst. Bull. Hyg. 31:825, 1956.)

582. Gregory, J.: Occupational factors in the incidence of bronchitis. Trans. Assoc. Ind. Med. Officers 5:2-9, 1955.

A study of the incidence of chronic bronchitis and chronic cough was carried out on a group of employees, both gas works men and non-works or "district" men, in the Dudley district of the West Midlands Gas Board. Of the men 20 yr. and over, 168 were interviewed and sufficiently full records were available on 23 more. The data included occupational, medical and family histories, details as to places of residence and smoking habits and a clinical examination. The symptoms of chronic bronchitis were defined as cough, expectoration and exertional dyspnea, with no primary disease of the lungs or heart, while those for chronic cough were recurrent cough with expectoration, without dyspnea and no primary disease of the lungs and heart. The lung abnormalities found showed that the incidence of chronic bronchitis and chronic cough among the gas works men was 17.9/100, as compared to 6.3/100 among the district men. However, the age distribution in the 2 groups was not uniform, the gas works men, on the whole, being older. The incidence by age and years in the gas industry for the gas works men and for the district men are tabulated; this shows a definite increase in incidence with age and with time spent in the industry for the gas works men, while the rate for non-works men rises and then falls. A striking difference was noticed in the type of worker smoking more than 20 cigarettes/day, in that twice as many gas works men (34%) as district men (16.1%) smoked this amount, and of the men in the works those on the dustier or hotter jobs appeared to be the heavy smokers. Though

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Gregory, J. (continued)

this occurred, no evidence of a relationship between the incidence of bronchitis and smoking habits could be found. The incidence of bronchitis appeared to be similar throughout the Social Classes 3, 4 and 5. Three principal occupational factors were considered: dust, temperature and humidity and gases and fumes. The effects of exposure to various combinations of these showed that dust is undoubtedly the most important factor of the 3 in the incidence of bronchitis. A larger and more detailed investigation amongst employees in the gas industry would probably yield more information on the influence of each of these factors. A review of the literature on this subject confirms that there are occupational factors in the incidence of bronchitis; that undoubtedly dust is such a factor; and that temperature, dampness and fumes are possibly implicated.

583. Hardy, H.L.: Epidemiology, clinical character and treatment of beryllium poisoning. Arch. Ind. Health 11:273-9, 1955.

As sources of Be poisoning, the author lists the following Be-using operations: extraction of Be, fluorescent powder manufacturing, fluorescent lamp manufacturing and salvage, neon sign manufacturing, Be alloy manufacturing, Be metallurgy, ceramic operations, radio tube manufacturing, atomic development and, finally, the resulting neighborhood contamination. The apparently incriminated Be compounds are: BeF_2, $Be(OH)_2$, $BeCl_2$, $BeSO_4$, $MnZnBeSiO_4$ and BeO(Be). The author discusses epidemiologic, clinical and therapeutic aspects of Be poisoning. In the description of the clinical picture observed, she differentiates between acute and chronic Be poisoning. For the latter, classifications are given, as described in Arch. Ind. Health 12:174-81, 1955. Case reports are included for illustration of the clinical symptoms. In the conclusions, the author states that the publication should be considered as a progress report on the accumulating knowledge of Be poisoning. A registry is being set up to collect and correlate such data, the Beryllium Case Registry. It is located at the Massachusetts General Hospital, Boston and is supported by the Atomic Energy Commission, Division of Biology and Medicine, Washington, D.C. Such a registry can help clinicians treating patients, industrial hygienists in plants where Be compounds are in use, and investigators who want to check animal studies with human pathology. The freedom of the Ohio Be extraction and alloy manufacturing plant population from acute Be pneumonitis with the introduction of industrial hygiene protection is noteworthy in establishing the AEC recommended MAC of 25γ of Be/m.^{3} for any exposure, however short. Since new cases of chronic Be disease continue to appear 5 yr. and longer after the last exposure, time only can tell whether or not the arbitrarily recommended figure of 2γ of Be/m.^{3} for chronic exposure is a reliable figure.

584. Hardy, H.L.: The disability found in persons exposed to certain beryllium compounds. Arch. Ind. Health 12:174-81, 1955.

The author states that epidemiological, industrial hygiene, clinical and animal experimental evidence documents the conclusion that a distinctive disease occurs in Be-using industries, exclusive of those using finished low Be alloys (less than 2%) and those engaged in mining beryl ore. There is adequate evidence that no Be extraction and alloy-manufacturing industry in the U.S., of which we have knowledge, is completely free of the worker illness fulfilling the criteria laid down in this paper for the diagnosis of chronic Be poisoning. Knowledge of the disease has been reported for <20 yr., for 10 yr. in the U.S. In order to illustrate the presently known clinical syndromes for the 1955 Saranac Symposium, the following temporary classification of Be disease, based on the

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Hardy, H.L. (continued)
clinical experience at the Massachusetts General Hospital, has been prepared. An example of a case report is given for each category. 1) Be effect - no disability, 2) Be effect - probable disability, 3) mildly symptomatic Be disease, 4) moderately disabling Be disease, 5) severely disabling Be disease, 6) completely disabling Be disease, 7) recovery from Be disease, a) with residual evidence of irreversible pathology, b) with no evidence of the disease.

585. Kotin, P. and Falk, H.L.: Local and systemic responses to experimental exposure to atmosphere pollutants. Proc. 3rd Natl. Air Pollution Symposium, Pasadena, Calif., April 18-20, 1955:141-9, 1955.

The action of artificial smog, made by reacting gasoline and O_3 in high (16-30 ppm), medium (6-15 ppm) and low (0-5 ppm) concentrations was observed both in vitro and in vivo experiments on animals and man. Effects on amino acids, serum and plasma proteins, enzymes, respiratory physiology, including changes in CO_2 vol. %, O_2 vol.% and hemoglobin in g.-%, and effects on respiratory rate, amplitude and blood pressure were observed. Also, toxicity studies were made on intact hosts. Representative mammalian species were exposed to 1-2 ppm O_3 for 5-6 mo. for 24 hr./day, 7 da./wk. Demonstrable effects were minimal. The following conclusions are drawn from these experiments. "Smog in realistic concentrations produces no demonstrable physiologic or morphologic changes in presumably healthy animal species. Smog in concentrations of 15 ppm (30 X the average concentrations on a smoggy day) produces certain physiologic changes that are all of a low order of magnitude. These changes rapidly disappear following removal of the animals from the exposure chambers and repeated exposures show no cumulative effect. Studies on healthy human volunteers, though limited, indicate that following exposure to realistic concentrations of smog, blood gas changes are negligible with minimal alterations in residual air following deep, fast breathing of smog. Organisms have sufficient physiologic reserve so that single exposure followed by recovery periods uniformly failed to produce any evidence of toxicity; this does not apply to carcinogenicity."

The authors' data suggest, rather, that air pollution can be harmful from a chronic or potentially carcinogenic viewpoint. A significant yield of skin cancers from the applications of atmospheric, aromatic extracts and of gasoline- and diesel-engine exhaust extracts on the skin of C57 black mice has been obtained. Application of atmospheric aliphatic extracts has also produced skin cancers in C57 black mice. A-strain mice have also been exposed to the inhalation of smog composed of gasoline, O_3 and UV light. The production of tumors was twice that in the controls and the number of animals with multiple tumors was 3-5 times greater in the former than in the latter. These tumors are classical adenomata. The pattern and site of soot deposition in human and experimental animal lungs are strikingly similar to the sites of predilection for the development of human lung cancer. Also, the disappearance of carcinogenic materials from inhaled soots suggests their destruction in the tracheobronchial tree or, more likely, their absorption into the epithelium with the possible mediation of a carcinogenic effect.

586. Lawther, P.J.: Effects of inhalation of sulphur dioxide on respiration and pulse-rate in normal subjects. Lancet 2:745-8, 1955.

The author was unable to confirm the findings of Amdur, Melvin and Drinker (Lancet 2:758-9, 1953), viz., that inhalation of 1-8 ppm SO_2 produced consistent changes in respiration and pulse rate. Possible reasons for this failure are: (1) changes attributed to SO_2 might have

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Lawther, P.J. (continued)
been due to psychological reaction to the experiment; (2) subject's unfamiliarity with the procedure might have produced the change; (3) during inhalation through a face mask, detection of an unfamiliar smell might have occurred which could have altered respiratory pattern and increased pulse rate and (4) Londoners might be "immune" to the effects of low concentrations of SO_2.

To test these possibilities, 18 healthy adult males (21-40), of whom 6 lived in rural Kent, inhaled 0 ppm, 5 ppm and 10 ppm SO_2 by mouth; 6 of these also inhaled through the nose from a close-fitting face mask. Each exposure consisted in a basal period of 10 min., the actual exposure period of 10 min. to 0, 5 or 10 ppm SO_2, and a recovery period of 10 min. At 2-min. intervals, the expired air of the individual was switched into a spirometer, 10 exhalations being collected at a time, and tracings taken on a moving drum. The pulse rate was noted at the same time. The individual results in all the groups show no consistent change. When all the groups are considered together, the changes in pulse rate, respiratory rate and tidal volume observed before and after the inhalation of 5 or 10 ppm are very small and correspond to the small changes at 0 ppm exposure. Differences between the results in nose-breathing and mouth-breathing groups and between those in town and country groups are not significant at the 5% level. One subject developed bronchospasm at 10 ppm. None of the others were distressed by the gas. Most subjects detected the gas, some coughed or reported irritation with the higher concentrations and a few signaled that they detected the gas when none was being given. 6 volunteers were also exposed to 20 ppm SO_2. Again no consistent effects on the values measured were noted. The gas was irritant to all. An additional experiment is reported in which a physiologist, who had been discomforted by SO_2 in the past, asked to be exposed to 10 ppm in the same manner as above. In the 3rd min. of exposure he developed severe bronchospasm, the clinical symptoms of which persisted for ca. 1 hr.; however, he completed the trial. His respiratory rate and tidal volume increased considerably, but the significance of this change cannot be assessed.

587. Lerner, R.: Bronchial asthma and asthmatic bronchitis in the chemical industry. Ind. Med. Surg. 24:454-8, 1955.

A statistical study of the occurrence and etiology of asthmatic distress among 965 workers in a chemical plant in Basel showed that 132 (13.7%) suffered from bronchial asthma or asthmatic type bronchitis. The % of the total number of workers who had been exposed to each of 8 groups of chemicals and were asthmatics was determined. 11.1% of those exposed to aromatic amines were asthmatics; to solvents, 11.4%; to volatile Cl^-'s ($POCl_3$, PCl_3, PCl_5), 28.2%; phosgene, 16.4%; nitrous gases, 16.4%; volatile acids and bases, 19.3%; formaldehyde, 16.3% and dichlorether, 39.7%. Many asthmatics were exposed to more than 1 chemical. Thus, the highest morbidity rates occurred in those exposed to the volatile Cl compounds, especially 1,2-dichlorethylmethylether, $POCl_3$, PCl_3 and PCl_5. In addition, 70 workers with asthmatic bronchitis of bronchial asthma were examined medically. Respiratory tract pathology had occurred in 29 cases previous to the asthmatic distress; 2 employees already had moderate bronchial asthma before they started working. Evidence of allergic disease was found in 27 workers. 19 workers had survived 1 or more episodes of acute intoxication, which marked the beginning of the asthmatic distress for 8 of them. The exposure period at the plant varied greatly and averaged 13.5 yr. Subjective complaints included acute, typical, dyspneic nightly attacks, dyspnea during the course of work during stress, dyspneic when resting, chronic cough many times producing mucoid grayish-white sputum.

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Lerner, R. (continued)
Objective findings included cyanosis, emphysema, wheezing, rhonchi and dry and moist rales. This clinical picture does not differ from nonindustrial asthma. Prognosis was poor because of chronicity, inadequate therapy and possible complications, e.g., emphysema. Ability to perform physical labor was frequently impaired.

588. Levin, M.L., Kraus, A.S., Goldberg, I.D. and Gerhardt, P.R.: Problems in the study of occupation and smoking in relation to lung cancer. Cancer 8:932-6, 1955.

In order to study the efficiency of a method to be used in further investigations of the apparent risk of various types of cancer in certain occupations, 137 male lung cancer patients and 396 patients suffering from other types of cancer were compared as to age, residence, smoking habits and occupational history. Not included in the study were cancer of the skin, respiratory tract, hemapoietic system, urinary tract, stomach and oesophagus. The occupational history covered information on all positions ever held, and all physical and chemical agents the persons in the lung cancer group had ever been exposed to. Of 18 major occupational groups, comprising 61 occupations, 2 were most frequently represented: workers in the metal production and in construction. Of 406 exposure classes, 2 occurred most frequently: that to free silica or sand, and to iron dust and excessive heat. Persons belonging to either were classified as "significant" occupational group, and comprised 45.3% of the lung cancer and 27.8% of the control groups. An excess of certain occupations not accounted for by age, sex or place of residence and also the relative effect of smoking on lung cancer incidence became evident during collection and tabulation of the data. The information was evaluated by converting the relative distribution into the relative incidence indicated by this distribution. The excess risk of developing lung cancer attributable to occupation in all smoking categories ranged from 1.5 to 4.3 X higher in the "significant" than in the "nonsignificant" occupations, the risk in both groups being lowest for noncigarette smokers (1%) and highest for those smoking ≧20 cigarettes/day. The factor of occupation least affected heavy smokers, and heavy smoking exerted the greatest effect in occupations not associated with lung cancer. A greater incidence in cigarette smokers in "significant" occupations (23.7% of those smoking ≧20 cigarettes had lung cancer) indicates an additive effect of smoking and occupation. It is pointed out that in any such study, the control group should be representative of the "source population" rather than of the general population, i.e., differing only as regards the presence of cancer and the factor studied. Reference is made to 2 similar studies, conducted by the Public Health Service in cooperation with the Veterans Administration and by the American Cancer Society, of 200,000 and 2,855 persons, respectively, which had demonstrated that the factor of occupation does not account for the higher incidence of lung cancer in smokers. An evaluation of the collected data leads to the conclusion that there is a causal relationship between cigarette smoking and lung cancer and that there is sufficient evidence to justify the deduction that the discontinuance of cigarette smoking might contribute to a decrease in lung cancer incidence.

589. Litkens, V.A.: (General toxic action of sulfur dioxide.) Gigiena i Sanit. 1955:No. 8, 15-19.

Air samples, collected in various metallurgical plants, showed that SO_2 concentrations in smelting rooms ranged from 0.015 to 1.500 mg./l. air. The action of SO_2 on the organism was studied in a comparison of the incidence of disease in a Cu-smelting plant (A) with that in a ferrous

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Litkens, V A. (continued)
metallurgical plant (B) in the Ural, operating under similar climatic and working conditions, except for the considerable emission of SO_2 in the former plant. The incidence of disease, established at 100 for B, was 22-26% higher in A: all diseases - 123, grippe - 118, t.b. of the respiratory organs - 144, pneumonia - 222 and gastrointestinal disorders - 189. Within A, a comparison of the incidence, for the past 5 yr., of disease in all workers with that in foundry workers alone showed an excess of 40% in the latter, with regard to respiratory diseases of even 60%. The incidence in all workers of A (controls) being established at 100, that in foundry workers was found to rise with exposures to increased concentrations of SO_2 (given in mg./l. air): at 0.090, bronchitis - 104, pneumonia-133; at 0.365, bronchitis - 293, pneumonia - 183. In foundry workers exposed to high concentrations of SO_2, gastrointestinal disorders occurred 3-3 1/2 X, respiratory diseases 2 1/2 X more frequently than in the total control group. The influence of duration of exposure on the incidence of both respiratory and hepatic disorders is demonstrated when establishing it for <6 yr. exposure at 100: respiratory diseases - 178 in workers exposed 16 yr. and longer, hepatic diseases - 199 at 13-15 yr., 170 at 16 yr. and more exposure time. The modifying factor of age increase is not considered. Blood samples of workers exposed in the various sections of A contained SO_2 (given in mg.%) at the following range of concentrations (average): 0.025-at the blast furnace, 0.063 - at the reverberatory furnace. Hepatatrophia (the liver extending up to 3 cm. over the costal arch) was found in 30% of all workers examined. Characteristic impairment of lung functions was also found (no details given).

Generally, increase in both the concentrations of SO_2 in the working atmosphere and in duration of exposure resulted in a rise in the incidence of: chronic bronchitis, laryngitis, pharyngitis, pulmonary sclerosis, emphysema as well as myocarditis. In conclusion, the author summarizes the action of inhaled SO_2 which circulates in the blood, affecting intricate enzyme processes and causing the changes described above.

Strict hygienic control measures are recommended.

590. McAdams, A.J.: Bronchiolitis obliterans. Am. J. Med. 19:314-22, 1955.

Bronchiolitis obliterans, a rare entity, should be classified with diseases of unremitting dyspnea. The clinical picture is distinctive and correlates with the generalized involvement of respiratory bronchioles by obstructing lesions. Of particular importance in diagnosis is a roentgen pattern simulating miliary t.b. Pulmonary infection or the inhalation of irritant fumes are the most common causes. The fatal case reported in detail was due to inhalation of dense fumes of NO_2 from the explosion of flasks containing red fuming HNO_3. The symptoms at first consisted of a cough and tightness of the chest. 3 wk. later, the cough became severe and his temperature rose. The symptoms including severe shortness of breath became steadily worse; he was hospitalized 4 wk. after the accident and died 30 hr. after admission. NO_2 is the single most common cause of bronchiolitis obliterans. Attention is drawn to the fact that poisoning by oxides of N fumes is not at all uncommon.

591. Morken, D.A. and Morrow, P.E. Control and measuring systems on an apparatus for the study of respiratory tract retention. U.S. Atomic Energy Comm. Doc. (Rochester Univ., Contract W-7401-eng-49) 1955.

A technical description of the various electronic components of a new apparatus for the study of respiratory deposition and retention is given with appropriate wiring diagrams. The performance characteristics of

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Morken, D.A., et al. (continued)
the apparatus are reported in the form of various tests and calibration procedures which have been applied. The equipment has been employed in aerosol studies in man to a limited extent. The operation of the apparatus indicates that it will permit the study of pulmonary deposition in relation to both the characteristics of the aerosol and the physiology of respiration. (Abst. Arch. Ind. Health 14:573-4, 1956.)

592. Randig, K.: Zur Ätiologie des Lungenkrebses. Fragen und Ergebnisse. (Etiology of lung cancer. The problem and conclusions.) Deut. med. Wochschr. 80:718-24, 1955.

A report on the author's own investigation is preceded by a discussion of the following problems associated with the etiology of lung cancer: occupational exposure to substances established as causing or as contributing to the incidence of lung cancer; the significance of air pollution due to industries and the influence of smoking habits, both in the light of differences between urban and rural incidence; the possibility of infectious diseases of the respiratory tract acting as predisposing factor and finally, the role of tobacco smoking in the development of lung cancer. (No further reference to urban vs. rural residence is made.)

For the study reported here, detailed questionnaires were filled out by the following persons: 448 patients with bronchial cancer (415 males (M), 33 females (F)) and 512 controls (381 M, 131 F) from 30 hospital wards in West Berlin. The controls, ranging in age from 45 to 75 yr., did not include previous smokers who had given up smoking because of a chronic disease, nor persons suffering from cancer of other sites. The information recorded included the following factors concerning the environmental history: tobacco consumption during a period of 20 yr. (allowance was made for a reduction during the war years), smoking habits, occupational toxic exposures and previous pulmonary diseases.

No clear predominance of occupations providing exposure to atmospheric contaminants was found among the lung cancer group, but the cancer group included more men who worked with cars (18 against 5) and more chemical workers, gas workers, stokers, street cleaners and asphalt workers (19 against 9) than the controls. No difference was found in the previous history of respiratory diseases in men; more respiratory diseases had occurred among women with lung cancer than among the females of the control group, but the number of female cases was small. Smoking histories showed an association with the incidence of lung cancer similar to that which has been reported by other investigators. From these data, the author estimates that the risk of lung cancer, supposing it is 1 for nonsmokers, would be, for the average smoker: M 5.1, F 2.2, for M heavy smokers, it is estimated at 9.4. Contrary to the findings obtained from other reported studies, no difference was found between the proportions of cigarette, pipe and cigar smokers in the two disease groups. The results with regard to inhalation also are anomalous, i.e., there was an excess among cigarette smokers and a deficiency among pipe and cigar smokers in the lung cancer group. (44 references.)

593. Straub, R.A.: Potential dangers from exposure to diesel locomotive exhaust. Ind. Med. and Surg. 24:353-8, 1955.

The toxic diesel exhaust constituents considered in this paper are CO, N oxides, aldehydes and similar chemicals, allergens and cancerogens. Limits of concentration are reviewed, both maximum allowable concentrations for continuous and prolonged exposure and high concentrations for short periods of exposure. NO_2 can be inhaled up to 100 ppm for $<1/2$ hr.,

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Straub, R.A. (continued)
but the MAC for prolonged exposure is 5 ppm. The effects of CO are proportional to the product of time X concentration. The probabilities of exposure in railroad operation are discussed. In general, the probabilities of harmful exposures are remote. Diesel engines are infinitely less dangerous to operate than gasoline power. However, specific instances must be tested. Though CO is colorless and dangerous, the other gases present in diesel exhausts will usually give ample warning. The medical consequences of exposure to CO, oxides of N, carcinogens, aldehydes and allergens as reported in the literature are reviewed. Only 6 cases of claims of any consequence have occurred according to a recent survey. Other claims of relative unimportance have also been reported. The legal aspects of some of the claims are discussed.

594. Vigliani, E.C. and Zurlo, N.: Erfahrungen der Clinica del Lavoro mit einigen maximalen Arbeitsplatzkonzentrationen (MAK) von Industriegiften. (Experiences of the Clinica del Lavoro with some maximum allowable concentrations (MAK) of industrial poisons.) Arch. Gewerbepathol. Gewerbehyg. 13:528-34, 1955.

During the past 4 yr., the Toxicological Laboratory of the Milan Clinica del Lavoro has carried out, both by analyses of air samples of various working atmospheres and by examinations of workers, an appraisal of the MAC's established in 1954 by the American Conference of Governmental Industrial Hygienists (ACGIH). Comments are given for 8 of the 24 substances where the tabulated limits of the Laboratory (MCL) differ from those approved by the ACGIH. (See table for comparison of the values, for minimum effective concentrations (EC) and the effects detected by the MCL.) --- In conclusion, some general problems are discussed, such as: adaptation to the poison in relation to the MAC's established, for substances like CO, CH_2O, NH_3, SO_2 etc.; the differentiation between acute and chronic poisons; the addition, in a separate column, of data on ports of entrance, blood and urine values, etc.

Substance	ACGIH ppm	MCL ppm	EC ppm	Effects
Alkali chromate Chromic anhydride	0.1 mg./m.^{3}	0.05 mg./m.^{3}	0.11-0.15 mg./m.^{3}	ulcer of nasal septum, conjunctivitis, chronic bronchitis; after 3 yr.: cancer of nasal septum and of lungs
Parathion	0.1 mg./m.^{3}	0.0007 mg./m.^{3} (TEPP)	=	0.07-0.12 mg./m.^{3} Parathion, with regard to cholinesterase inactivation
Acetic acid	10	20		7-12 yr. of exposure to 60 ppm, including that of 1 hr./day to 100-260 ppm, resulted in only slight irritations.
Acetone	1,000	500	700, 1,000	3 hr./day, for 7-15 yr. exposure caused inflammation of air passages, digestive tract; vertigo, asthenia.

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Vigliani, E.C., et al. (continued)

Substance	ACGIH ppm	MCL ppm	EC ppm	Effects
Ammonia	100	50	100	Irritation of air passages, conjunctivitis
			20	similar effect in workers not accustomed to exposure
Carbon Monoxide	100	50 75 (suggested, to avoid possibility of effects)		workers accustomed to 100 ppm for 8 hr./day showed no effects
Ethyl benzene	200	100	200-250	inflammation of upper air passages and conjunctiva, dermatitis, leukopenia, hyperreflexes of tendons
Nitrous fumes	5	15		exposure to 30-35 ppm for several yr. had no effect; 15 ppm should be safe in absence of O_3.

595. American Conference of Governmental Industrial Hygienists: Threshold limit values for 1956. Arch. Ind. Health 14:186-9, 1956.

Established and tentative values are tabulated for the maximum average atmospheric concentration of contaminants to which workers may be exposed for an 8-hr. working day without injury to health. These were adopted by the American Conference of Governmental Industrial Hygienists at their 18th Annual Meeting, April 21-24, 1956, on the basis of the best available information from industrial experience, from experimental studies and, when possible, from a combination of the two. These values are not intended for use, or for modification for use, in the evaluation or control of community air pollution or air pollution nuisances. Earlier tabulations had been published in the Archives as follows:

ACGIH: Threshold limit values. Arch. Ind. Hyg. and Occupational Med. 2:98-100, 1950.
ACGIH: Threshold limit values for 1951. Arch. Ind. Hyg. and Occupational Med. 4:398-400, 1951.
ACGIH: Threshold limit values for 1952. Arch. Ind. Hyg. and Occupational Med. 6:178-80, 1952.
ACGIH: Threshold limit values for 1953. Arch. Ind. Hyg. and Occupational Med. 8:296-8, 1953.
ACGIH: Threshold limit values for 1954. Arch. Ind. Hyg. and Occupational Med. 9:530-4, 1954.
ACGIH: Threshold limit values for 1955. Arch. Ind. Hyg. and Occupational Med. 11:521-4, 1955.

596. Bidstrup, P.L. and Case, R.A.M.: Carcinoma of the lung in workmen in the bichromates-producing industry in Great Britain. Brit. J. Ind. Med. 13:260-4, 1956.

A follow-up over ca. 6 yr. of the mortality experience of workers in the chromates-producing industry at 3 factories in Great Britain shows a statistically ($P = 0.005$) significant increase in the mortality from carcinoma of the lung. 12 deaths were recorded in the series used for statistical analysis and only 3.3 expected. In addition to these 12 patients, 3 more, 1 of whom is dead and 2 still alive, were reported from the same factories. This increased mortality is in accord with the findings of various authors

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Bidstrup, P.L., et al. (continued)
(e.g., Gross, E. and Kölsch, F.: Arch. Gewerbepathol. Gewerbehyg. 12: 164, 1943; Machle, W. and Gregorious, F.: Public Health Repts. (U.S.) 63:1114-27, 1948 and Baetjer, A.M.: Arch. Ind. Hyg. and Occupational Med. 2:487-504, 505-16, 1950) who have studied hazards to health in the chromates-producing industry in Germany and in the U.S.A. The possibility that the increase found by the authors could be due to a nonoccupational cause such as diagnostic bias, place of residence, social class or smoking habits has been examined, discussed and discarded, and it is therefore concluded that carcinoma of the lung must be considered as an occupational hazard in the chromates-producing industry in Great Britain. The data that were examined do not indicate anything about the nature of the carcinogenic occupational factor. The mortality experience of the chromates workers taking part in this investigation from neoplasms at other sites and from deaths from other causes does not seem to be altered from the mortality expected in a comparable section of the general population of England and Wales. (Mainly authors' summary.)

597. Goodwin, J.T., Jr., Bolze, C. and Morriss, F.V.: Smog experiments in large chambers. Abstracts of Papers 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956. p. 6B.
Smog formation is studied in a pair of 2100 ft.^{3} glass reaction chambers. Smog, indistinguishable from that found in Los Angeles, is rapidly formed when automobile exhaust is irradiated by sunlight, even when the hydrocarbon and NO_2 concentration are at the relatively low concentrations found in Los Angeles during smoggy periods. Studies in these large reaction chambers have an advantage, in that enough air is available so that many measurements may be made without interrupting the smog-forming reactions. Temperature, relative humidity, light intensity, oxidant concentration and the concentration of NO and NO_2 are all measured automatically. Rubber cracking properties are measured regularly and numerous wet analyses are made at intervals during the reactions. A panel of 20 students make measurements of eye irritation by entering the chambers at regular intervals.

598. Higgins, I.T.T., Oldham, P.D., Cochrane, A.L. and Gilson, J.C.: Respiratory symptoms and pulmonary disability in an industrial town. Survey of a random sample of the population. Brit. Med. J. 2:904-10, 1956.
In 1954 the Pneumoconiosis Research Unit of the Medical Research Council carried out a survey of the male population aged 55-64 of Leigh in Lancashire. One of the objects of this survey was to compare the prevalence of respiratory symptoms and disability in miners with that found in men who had worked only in other occupations. This paper sets out the method adopted for securing as far as possible a random sample of men, which ultimately consisted of 135 miners and ex-miners and 86 men who had worked only in other occupations (here designated nonminers). The procedure of study is described and consisted in taking occupational histories, recording of respiratory symptoms with grading of breathlessness, measurements of height and weight, determination of ventilatory capacity and X-ray examination. Tables and description set out the results of the investigation. Pneumoconiosis was found to be present in 23% of the miners and ex-miners. Chronic bronchitis was found in 10.7% of the nonminers, in 26.7% of the miners without pneumoconiosis and in 12.9% of the miners with evidence of pneumoconiosis. The results of analyses by social class, smoking habits and dust exposure are also given. Some of the conclusions of the survey are:--(1) miners and ex-miners had significantly

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Higgins, I.T.T., et al. (continued)
more "chronic bronchitis," a lower ventilatory capacity and more respiratory symptoms than men who had never worked in mines, (2) "Miners without pneumoconiosis were on the average more disabled than those with early simple pneumoconiosis" and (3) the "differences between miners and non-miners could not be ascribed to differences in social class or smoking habits, and in the miners there was no obvious relationship between length of exposure to dust and bronchitis." (Abst. Bull. Hyg. 32:50, 1957.)

599. Kleinfeld, M. and Giel, C.P.: Clinical manifestations of ozone poisoning: Report of a new source of exposure. Am. J. Med. Sci. 231:638-43, 1956.

Three cases, ascribed to O_3 poisoning, are described which occurred close together among men who had been welders for many yr., but had recently been called to a new technic of electric welding known as consumable electrode gas-shielded arc welding. This process used as one of the electrodes a continuously fed bare wire which was of the same composition as the material welded. The electrode is melted and consumed in the process and requires a current of up to 500 amp. 1 man had worked at the new process for 2 wk., another for 3 da. and the 3rd for 2 wk. The symptoms included dyspnea, headache, substernal oppression and illness in excess of any clinical findings. A diagnosis was only arrived at when the 3rd case occurred; then atmospheric analysis disclosed the presence in the workshop air of 9.2 ppm O_3; the accepted threshold limit is placed at 0.1 ppm. Increased bronchovesicular markings were seen in chest X-ray films, all of which cleared away during convalescence which, however, was prolonged. The new process calls for engineering control to eliminate the hazard; it should include isolation of the process and local exhaust ventilation. (Abst. Bull. Hyg. 31:1120-1, 1956.)

600. Morando, A.: Contributo sperimentale e clinico alla patologia da nebbie de acido solforico nell'uomo. (Experimental and clinical contribution to human pathology due to sulphuric acid fumes.) Med. lavoro 47:557-61, 1956.

Normal human subjects, not used to H_2SO_4 fumes, were made to inhale for 5-15 min. air polluted with H_2SO_4 concentrations from 0.35 up to 5 mg./m^3. 77% of the inhaled acid is on the average retained in the respiratory system. Even at concentrations that are not subjectively detected by the people under examination, the respiratory flow rapidly increases and remains high until some min. after the end of the test; the increase is more evident at higher concentrations. The respiratory flow increase involves a reduction of the percentage of the acid retained in the respiratory system, and can be considered as a defense mechanism. 57 workers employed in the H_2SO_4 production department were also followed up for several yr.: there was no evidence of a particular increase in the occurrence of bronchial or lung diseases, nor of conjunctival or pharyngeal irritation. Numerous cases of gastritis and gastroduodenitis, gastric ulcers and digestive troubles were observed. Chronic exposure to relatively low concentrations of H_2SO_4 as those to which the workers under examination were exposed, seem to be able of determining gastrointestinal tract lesions more easily than respiratory system lesions. (Author's summary.)

601. Pattle, R.E. and Collumbine, H.: Toxicity of some atmospheric pollutants. Brit. Med. J. 2:913-6, 1956.

The concentrations of SO_2 reported in smogs (ca. 2 ppm or less) had no detectable effect on any animals used. However, a small portion (perhaps

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1/100) of human beings have been found to suffer from bronchoconstriction when inhaling low concentrations of this gas. In some cases slight tightness of the chest could be felt with concentrations as low as 1 ppm. It has been suggested that in smog atmospheres SO_2 could be absorbed on to smoke particles which would be inhaled and penetrate deeply into the lungs. Although the SO_2 might be more toxic in this form than in the gaseous state, it would not be detected in the usual apparatus for measuring SO_2 as the air is filtered before entering the absorbing solution. The toxicity of SO_2 in a concentration of about 2,700 mg./m.^{3} (1000 ppm) to mice was enhanced by the addition of 100 mg./m.^{3} of smoke from a kerosene lamp. The CtD_{50} (dosage or concentration time, to which a batch of animals has been exposed by the time 50% have died) for the mixture was about 40% greater than that for the gas alone. In 1 experiment where the mean SO_2 concentration was the same (2,560-2,590 mg./m.^{3}) for the clean and smoky atmospheres, at approximately 300 min. (292-295 min.) the mortalities were: clean atmosphere, 3/25; smoky atmosphere, 16/25. The final estimated CtD_{50}'s in the case last described were only in the proportion of 1:2. The dosage of smoke administered was large and the higher mortality in the smoky atmosphere is not surprising. At necropsy the lungs showed intense congestion, areas of consolidation, collapse and emphysema, and traces of edema. Previous exposure of mice to somewhat lower but still massive dosages of smoke (40 mg./m.^{3} for 22 hr.) actually increased their resistance to subsequent exposure to SO_2 (c. 3,000 mg./m.^{3}; c. 1,000 ppm). The ratio of the CtD_{50}'s for smoked to unsmoked mice was found to be 1.55 while after 200 min. 20/49 unsmoked mice and only 6/49 of the pre-smoked group had died. Other experiments have given similar results so that it is undoubtedly a real effect. To determine whether smoke acquires any peculiar irritant properties by being in contact with SO_2, a flow of smoky air was divided into 2 portions, 1 of which was administered directly to 20 mice, while the other was mixed with SO_2 (5,070 mg./m.^{3}; 1,900 ppm). The SO_2 was then removed from this 2nd portion of air by bubbling through Na_2CO_3 solution, and the resultant air flow, with its burden of smoke, was administered to a 2nd batch of 20 mice. Prolonged exposure (77 hr.; average smoke concentration 50 mg./m.^{3}) caused no fatalities in either group; 7 mice in each batch were kept for 3 mo. and they remained in good health. Histological examination of the lungs of all the mice showed no differences between the 2 groups. In experiments with H_2SO_4 mist, the estimated LC_{50} (median lethal concentration) for guinea pigs with an 8-hr. exposure at room temperature (20 C.:) was 28.8 mg./m.^{3}, using a mist of 2.7μ MMD (mass median diameter) and 60.9 when the particle size was 0.8μ. Keeping the particle size constant (0.8μ) and reducing the temperature to 0 C., the LC_{50} was 49.0 mg./m.^{3}. Thus increased particle size and reduced temperature increased toxicity. The other species examined (monkeys, goats, rabbits, rats and mice) were much less sensitive to H_2SO_4 mist and in 1 experiment a rabbit survived a concentration of 400 ppm for 4 da. The guinea pig is known to be especially susceptible to conditions inducing bronchial spasm, and it is those individuals of the human species with a similar predisposition who are the more severely affected by smog atmospheres. In experiments with human subjects, mist concentrations of 10 ppm with the MMD of the particles about 1μ were highly irritant to the throat, although with prolonged exposure this irritation tended to decrease. If repeated coughing occurred, pain developed in the upper part of the chest. Most of the subjects suffered no long-term effects from an hour's exposure to this mist, but 1 subject exposed for 30 min. had "wheezing," coughing and expectoration for some hr.; another subject continued to "wheeze" for

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2 mo. Increasing the particle size of the mist also increased the irritancy; thus a mist of particle size about 1.5μ MMD was as irritant at 5 ppm as the former mist at 10 ppm. NH_3 annulled the irritant properties of H_2SO_4 mist and also those of atmospheres containing SO_2. MgO smoke removed SO_2 from the atmosphere, but even when present in excess did not affect the irritant properties of H_2SO_4 mist. Smoke itself seemed very inert so far as its acute toxicity was concerned. Experiments indicated that smoke from a kerosene lamp had a median lethal dosage to mice of the order of 1,500 mg./m.^{3} for 200 min. The effect of coal-tar distillates was irregular; in 1 case dosages of 2,000 mg./m.^{3} of solid and liquid tar for 500 min. produced no fatalities among exposed mice, but in another experiment with guinea pigs and mice there were deaths due to irritation of the whole respiratory system. Wood distillates have a much greater content of irritant aldehydes than coal distillates, but the effect is masked by the presence of CO in the wood gas. When suitably diluted they cause damage to the whole respiratory tract, especially to the trachea and bronchi. Mice, guinea pigs and rabbits were exposed for varying periods of time to the fumes from a single-cylinder diesel engine under 4 conditions of engine-running. Concentrations of CO, NO, NO_2, aldehydes, V and several other substances were determined. The 3 main toxic agents were irritant aldehydes, NO_2 and CO. Each was always present in the diesel fumes, but their relative importance varied with running conditions. NO was always present in greater quantities than NO_2; toxicity and effects of NO were somewhat similar to those of CO. No V was found. The unsaturated aldehydes, acrolein and crotonic aldehyde, were highly irritant to man and caused lacrimation in concentrations of 1 and 4 ppm, respectively, while the corresponding saturated compounds, propionic and butyric aldehydes, were almost nonirritant at 200 ppm. Acetaldehyde, isobutyric aldehyde and n-valeric aldehyde are likewise almost nonirritant. Formaldehyde was intermediate between the 2 groups, 12 ppm producing severe irritation. Exposure of mice, guinea pigs and rabbits to 24.4 mg./m.^{3} (10.5 ppm) acrolein for 6 hr. caused the death of about 50% of each species. The post-mortem picture was one of severe tracheobronchitis with pulmonary edema, consolidation, congestion and emphysema. Filter samples taken at the Dunn Laboratories at St. Bartholomew's Hospital in the fog of Jan. 4-6, 1956, were alkaline (maximum equivalent to 0.16 ppm NH_3, SO_2 concentration 1.16 ppm) up to 4:20 a.m. Jan. 5 whereas samples taken from 9 a.m. on that day until the fog dispersed on Jan. 6 were acid (maximum 0.05 ppm as H_2SO_4). The fog when inhaled through the mouth produced slight tickling at the back of the throat, similar to that produced by inhaling H_2SO_4 mist in very small concentrations (<0.1 ppm). The irritation was very inconstant, and was not severe enough to cause coughing; it was not possible to determine whether it was alleviated by NH_3. It was not present when a Siebe Gorman "microfilter" was worn. On this occasion, therefore, H_2SO_4 mist was not a major constituent; respiratory effects produced in otherwise healthy persons could be attributable to gaseous SO_2 alone. The fog had no effect on guinea pigs exposed to it. It is concluded that the toxic effects of smog are due to the action of small quantities of pollutants on exceptionally sensitive human beings; the substances concerned are probably, but not certainly, the S compounds.

602. Smyth, H.F., Jr.: Improved communication. Hygienic standards for daily inhalation. Am. Ind. Hyg. Assoc. Quart. 17:129-85, 1956.

The background of the establishment and publication of "Threshold Limit Values" is discussed. It is suggested that the name of "hygienic standards

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Smyth, H.F., Jr. (continued)
for daily inhalation" be adopted, since the terms "maximum allowable" and "threshold limit" concentrations are misleading. Such hygienic standards should specify 2 concentrations, one low enough so that no injurious effect can be expected in any workman, but which may have a detectable odor, cause eye, nose or throat irritation, and the second one causing somewhat more severe, but still reversible and nonprogressive effects. The values adopted for 1956 (except mineral dusts) are tabulated, together with the author's judgment of the following: most important effect of inhalation; predicted effects of daily 8-hr. inhalation at threshold limit, additional at twice and at 10 times threshold limit; important hazards other than from inhalation; nature of interpretive data (e.g., human toxicologic and physiologic data, etc.); the year the values were proposed. The data relied upon for these interpretations are summarized and briefly commented upon. 238 references.

603. Viikeri, M.: Über die röntgenologischen Lungenveränderungen bei unter dem Einfluss von Schwefeldioxyd arbeitenden Arbeitern. (X-ray changes in the lungs of workers in a foundry exposed to sulphur dioxide.) Zentr. Arbeitsmed. u. Arbeitsschutz 6:60-1, 1956.

Pulmonary X-ray examinations were made of 53 foundry workers of the average age of 45.9 yr. who had been working continuously for >10 yr. (average period 15.2 yr.) in an atmosphere containing SO_2 in a concentration which did not exceed the standard of 10 ppm, although it did on occasion become considerably greater than this for short times. The controls were 37 workers who had been exposed only occasionally to SO_2, and these were divided into two groups, one of 20 men of the average age of 46.2 yr. and the other group consisted of 17 men of the average age of 33 yr. who had worked for <10 yr. A normal X-ray picture was found in only 7 of the 53 exposed workers, whereas 6 out of 20 in the 1st group of controls and 14 out of 17 in the 2nd group showed no abnormality. The chief pathological findings in the 53 exposed workers were 4 cases of fibrosis, and 17 cases in which the hilum was enlarged and thickened without other evidence of disease. There were several cases of emphysema and of cardiac disease. Evidence of old pulmonary t.b. was found in ca. 1/3 of the 53 exposed workers, but also in 11 of 20 of the 1st group, and in 2 out of 17 in the 2nd group of controls. (Complete abstract.)

SEE ALSO: Holmes 10; Schnurer 28; Haythorn 33; Jötten 43; Agate 55; Magill 62; Goldwater 85; Sterner 88; U.S. Natl. Bur. Stand. 140; Poppe 167; Stanford Res. Inst. 173; del Vecchio 233; Anon. 252; Drinker 259; Dautrebande 289; Lehmann 606; Flury 618; Machle 624; Kraut 640; Dudley 646; Cralley 651; Dernehl 660; Schmidt 670; Hall 679; Falk 687, 688; Am. Cyanamid 697; Steiner 709; Bruce 729, 734; Austrian 736; Hatch 746; Kennedy 753; Sadoul 767; Craig 773.

IV EXPERIMENTS ON ANIMALS

604. Lewin, L.: Über die Giftwirkungen des Akrolein. Ein Beitrag zur Toxikologie der Aldehyde. (The poisonous effects of acrolein. On the toxicology of the aldehydes.) Arch. Exptl. Pathol. Pharmakol. 43:351-66, 1900.

Acrolein penetrates only into the injured epidermis. Erythema and a burning sensation of short duration result. Exposure of the eyes causes burning of the conjunctivae, not accompanied by lacrimation. The acute effects on the respiratory tract are severe. Upon inhalation of acrolein, there is a feeling of congestion in the head and of oppression in the lungs, accompanied by vertigo. An increase in the respiratory rate accelerates the process. The cumulative effect of prolonged and repeated exposure to even low concentrations is characterized by severe catarrhal inflammations of the larynx, pharynx and of the bronchial mucosae. Ingestion of small amounts of acrolein, swallowed with the saliva, leads to diarrhea. One "drop" of acrolein, added to a blood sample (no amount given), removes the erythrocytes within 5-8 min. The color of the blood changes to light red; no methemoglobin is formed.

In animal experiments, a single subcutaneous injection of acrolein, concentration 0.3-1.0 g., into rabbits, weight 860-1,036 g., and of 0.1 and 2.5 g. of acrolein into guinea pigs, weight 562 and 584 g., respectively, had the following local effects: catarrhal irritation of the eyes and hemorrhagic inflammation at the site of injection and several others. Other results observed were: pneumonia, due to the presence of acrolein in the blood, acceleration of the respiratory rate, followed by its decrease, dyspnea and death, occurring 0.5-6 hr. after the injection. Upon intraperitoneal injection, both respiration and pulse ceased within a few min. The author assumes that a secondary effect on the cerebrum, rather than a functional disturbance of the heart, takes place. In another experiment, 3 rabbits, weight 910-1,120 g., inhaled, for 2.5-4.75 hr., acrolein vapors at concentrations ranging from 2-8 "drops"/22 l. of air. The following symptoms were observed in the exposed animals: irritation and inflammation, decrease of respiration to a rate much lower than that of the injected animals, pronounced narcotic effects and somnolence which preceded the dyspnea and signs of suffocation. Tracheotomy was performed in 5 other rabbits which then were made to expire through Müller's valves into bottles filled with one of various reagents. Several minutes later, acrolein was subcutaneously injected, at concentrations of 0.02-1.0 g. Shortly afterwards, the author noticed the odor of acrolein in the expired air. The latter did not change the color of litmus paper, demonstrating that acrolein was expired as such and not as acrylic acid. The author concludes that the MLD for animals was 0.15 g. The ED should be established at a much lower concentration, but it varies widely with the individual susceptibility.

The effects of the exposure to other aldehydes are listed.

605. Kisskalt, K.: Über den Einfluss der Inhalation schwefliger Säure auf die Entwickelung der Lungentuberculose. Ein Beitrag zum Studium der Gewerbekrankheiten. (The influence of the inhalation of sulfurous acid on the development of pulmonary tuberculosis.) Z. Hyg. Infektionskrankh. 48:269-79, 1904.

Rabbits were exposed to the inhalation of SO_2 in the air before and after being infected with t.b. bacilli. Controls were provided for both inhalation and infection alone. In preliminary exposures, the inhalation of 300 ppm SO_2 was tolerated by the author for only a short time (not specified), while the severe irritating effects of 1,500 ppm made breathing impossible. A rabbit inhaling 730 ppm of SO_2 in the air for 9 hr. sat motionless and demonstrated anorexia but rapidly recovered after the termination of the

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Kisskalt, K. (continued)

exposure, the only remaining effect being opaqueness of the corneae subsiding one day later. The experimental SO_2 concentrations (those usually occurring in industrial exposures), inhaled for 9 hr./day, ranged from 50 to 76 ppm, with the exception of 170 ppm (accidentally) for one day (8th). 6-wk. old human t.b. bacilli in 0.5 cc. salt solution, grown on Hesse's agar (coagulated cattle serum with no sugar added) without animal passage, were intravenously injected as follows: a) 0.066 mg. on the 6th inhalation day, b) 0.13 mg. on the 2nd; 5-wk. old t.b. bacilli of the same strain with animal passage were inhaled by the experimental rabbits (and the t.b. controls) on the 4th day. The body weight of the rabbits ranged from 1240 to 2450 g. The results may be summarized as follows: there are considerable differences as to the susceptibility to and resistance against the action of inhaled SO_2 in the rabbits, e.g., one tolerated 730 ppm for 9 hr. without showing any injurious effects, others tolerated 70 ppm but died when exposed for 9 hr. to 170 ppm SO_2. In 4 out of 5 experimental rabbits, the inhalation of SO_2 accelerated and exacerbated the course of t.b. which was demonstrated by severe caseous pneumonia, by the greater size of the tubercles and by the occasional presence of tubercles in kidneys, liver or spleen as well as by some effects on the bronchi. The inhalation of SO_2 produced a predisposition for the development of t.b. in the exposed rabbits. This predisposition may be anatomical in nature (injury of the protective cell layer of the body surface skin which allows the microorganisms to penetrate) or may be due to effects on the physiologic or physicochemical defense mechanism of the organism. The SO_2 affects the blood and is probably injurious also to the other protoplasm. According to the difference in nature of t.b. between man and rabbit, the effects of the described exposure will be more pronounced in humans than in the animals.

Ranges of days between beginning of experiment and death (d- died, k- killed)			
exposures	experimental rabbits	controls for tuberculosis	controls for SO_2
a)	10 (d) - 71 (d)	8 (k) - 65 (k)	11 (d) - 71(k)
b)	62 (d) - 65 (k)	64 (k)	
c)	41 (d) - 58 (k)	38 (k) - 55 (k)	

606. Lehmann, K.B.: Neue Untersuchungen über die quantitative Absorption einiger giftiger Gase von Tier und Mensch durch den Respirationstraktus und seine Teile. Ammoniak, Salzsäure, Schweflige Säure, Essigsäure, Schwefelkohlenstoff. (Recent studies on the quantitative absorption of some poisonous gases by the various parts of the respiratory tract in animal and man. Ammonia, hydrochloric acid, sulfurous acid, acetic acid, carbon disulfide.) Arch. Hyg. 67:57-98, 1908.

The following methods were employed in the study of the absorption of inhaled gases in human subjects, cats and rabbits: 1) aspiration method: simultaneous collection of both inspired and expired air in inhalation chamber, 2) bottle method: nasal inspiration from one bottle, oral expiration into the other, 3) wash bottle method: inspiration from one wash bottle, filled with aqueous solution of the known gas, expiration into the other, filled with absorbent (inspiration as follows: a. by mouth into lung; b. nasally into lung; c. sucking in by mouth and blowing out by mouth, as in smoking), and 4) method using Müller's valves (for animal experiments only): similar to 3), the valves being used to control the connection between respiratory tract and wash bottles (inhalation through either tracheal cannula or tubes inserted into the nose). The following summarizes the information given on the gases inhaled, their concentration, inhalation times and methods, as well as % and location of absorption, in that sequence.

A. Experiments with human subjects. NH_3, at 0.1-0.3 N throughout, 20 min., method 3c: 79-87.8% absorbed, of which 63% were found in the sputum, the rest in the oral cavity; 5-10 min., method 3a: 91% absorbed, in sputum

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Lehmann, K.B. (continued)

70%, rest in oral and pharyngeal mucosae; 20 min., method 3b: 100% absorbed, in sputum <6%, the rest in nasal mucosa. HCl, 0.29 mg./l., 20 min., method 2): 96% absorbed; 0.38 mg./l., 5 min., 89% absorbed. SO_2, 0.38 and 0.68 mg./l., 30 min., method 1): 70 and 65% resp. absorbed. CH_3COOH, 2.0-3.0 mg./l., 3 min., method 1): apparently 100% absorbed. CS_2, 1.58-2.06, no time given, method 2), modified: 18.8-32.2% absorbed.

B. Animal experiments. NH_3, 0.1 N, 10-15 min., intratracheally (i.t.), 56% retained in lungs. HCl, 0.34-17.8 mg./l., 15-60 min., i.t. and intranasally (i.n.), 60-75% absorbed. SO_2, 1.09-16.7 mg./l., 15-30 min., i.t. and i.n., 46% absorbed. CH_3COOH, 7.9-87.7 mg./l., 30 min., i.t. and i.n., 70% absorbed. CS_2, 32.72-620.38 mg./l., 60 min., i.t. and i.n., 20.6% av. absorbed.

It is concluded: NH_3, depending on concentration and duration, even short exposures, e.g., occupational, may lead to an absorption of 75-100%. HCl, nasal inspiration by animals of up to 12.0 mg./l. air does not cause acid reaction in the trachea; no severe lung changes are observed. Absorption of low concentrations by humans is greater than that by animals. SO_2: animals show pulmonary edema, hemorrhages, occasionally emphysema; human subjects demonstrate severe eye and nasal irritation. One subject tolerated 0.38-0.68 mg./l. for 1/2 hr. CH_3COOH: the gas affected animals less than did HCl: tracheal hyperemia and occasional emphysema were observed; exposed persons showed mainly irritation. CS_2 caused slight bronchitis and rhinitis in exposed persons. As to the effects of inhalation of acid fumes in general, it is stated that both larynx and trachea proved well protected against effects of nasal inhalation. There was no difference in amounts absorbed between nasal and tracheal inhalation. The test methods employed did not warrant any definite conclusions as to absorption by the lungs.

607. Ronzani, E.: Über den Einfluss der Einatmungen reizender Gase der Industrien auf die Verteidigungskräfte des Organismus gegenüber den infektiven Krankheiten. I. Chlor, Schweflige Säure, Stickstofftetroxyd. (Influence of the inhalation of irritant industrial gases on the resistance of the organism to infectious diseases. I. Chlorine, sulfurous acid, nitrogen tetroxide.) Arch. Hyg. 67:287-366, 1908.

This is the first part of an extensive report on experiments carried out to establish the maximum concentrations of gases that can be inhaled by animals for a prolonged period of time without affecting their resistance to infections. Groups of rabbits, guinea pigs and pigeons were exposed 6 hr./day for periods of up to 1 mo., to inhalation of various concentrations given as one thousandth in the original of Cl, SO_2 and N_2O_4 in the air. One control group was provided for each experimental group. The effect of the exposure on the following phenomena was then examined: 1) the production of agglutinating substances, 2) the immunizing power of the blood serum, 3) the bactericidal power of the lungs, 4) the reaction of the susceptive animals to inoculation of both virulent and 5) attenuated virus, and finally 6) the reaction of immunized animals to virulent virus. Before each experiment, the animals' weight was determined, and both quantitative and spectroscopic blood tests were done. The air in the inhalation chambers was renewed every 0.5 hr. The methods employed for producing conditions 1-6 are described in detail. The results may be summarized as follows: 1) Inhalation, for a prolonged period of time, of more than 0.002 % of Cl, 0.05 % SO_2 and 0.05% N_2O_4, by animals, had the following effects: a) weight loss and change in the main blood constituents, b) decrease in the production of specific antitoxins and of the bactericidal power of the lungs, c) decrease of the resistance of the susceptible

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Ronzani, E. (continued)
animals to infectious diseases, d) the immunized animals became susceptible to infectious diseases, 2) inhalation for a prolonged period of time of concentrations not exceeding those mentioned above had no effect on the exposed animals. Thus, these concentrations may be considered as the maximum tolerated concentrations under the given conditions. In the conclusion, the author suggests an explanation for the fact that the inhalation of higher concentrations enhances the predisposition of the organism to infectious diseases. The effects on the cells bring about a functional change in the tissues and organs which, in turn, influences the metabolism. Thus, the organism is weakened and the resistance is decreased. However, these are highly complicated processes of partly biochemical nature, and more elaborate experimental and clinical study is necessary to give a clear picture of these reactions.

608. Ronzani, E.: Über den Einfluss der Einatmungen von reizenden Gasen der Industrien auf die Schutzkräfte des Organismus gegenüber den infektiven Krankheiten. II. Fluorwasserstoffsäuregas, Ammoniak, Salzsäuregas. (Influence of the inhalation of irritant industrial gases on the resistance of the organism to infectious diseases. II. Hydrofluoric acid gas, ammonia, hydrochloric acid gas.) Arch. Hyg. 70: 217-69, 1909.

Groups of guinea pigs, rabbits and pigeons were exposed 6 hr./day for various periods of time to inhalation of various concentrations of HF, NH_3 and HCl in the air. Employing the same experimental technics as reported in part I, the author again attempted to find the maximum concentrations of each gas that can be inhaled for a prolonged period of time without affecting the resistance of the exposed animals to infectious diseases. The following results were obtained: HF, at 0.066% caused the death of guinea pigs within 0.5 hr., of rabbits in 1.5 hr.; 0.025-0.003% caused death of guinea pigs in 1 hr.-1 day, of rabbits in 3 hr.-3 days. A concentration of 0.001% was lethal for only some animals within 6-29 days. On autopsy, they showed signs of catarrhal bronchopneumonitis and of interstitial pneumonitis, opaqueness of the cornea and ulcerations of the exposed mucosae. The animals surviving a concentration of 0.001% demonstrated considerable weight loss, marasmus and anemia. Their production of specific antibodies and of agglutinating substances was greatly reduced. The bactericidal power of the lungs as well as their resistance to infectious diseases were decreased, as was shown by the experimental exposure of the animals to bacilli of hematic anthrax, pneumonia, t.b. and typhoid fever. Under the given experimental conditions, the maximum tolerated concentration of HF was established at 0.0003%, since an exposure of the animals for 31 days was without effect. NH_3, at 0.05% caused death in several animals and severely affected the surviving animals, particularly with regard to their state of nutrition and their resistance to infectious diseases, as well as their blood and respiratory organs. The maximum tolerated concentration of NH_3 under the experimental conditions was established at 0.01%. An exposure of 30 days did not affect the animals. With HCl, an exposure of 50 days to the concentration of 0.01% did not affect the resistance to infectious diseases in the experimental animals. However, it brought about some slight changes in the weight and in the Hb content of the blood, indicating that a slightly higher concentration could cause dangerous effects.

609. Iwanoff, N.: Experimentelle Studien über den Einfluss technisch und hygienisch wichtiger Gase und Dämpfe auf den Organismus. Über einige praktisch wichtige Aldehyde (Formaldehyd, Acetaldehyd, Akrolein). XVIII. Tierversuche mit Akrolein. (Experimental studies on the influence on the organism of gases and vapors of technical and hygienic importance. On some important aldehydes (formaldehyde, acetaldehyde, acrolein). XVIII. Animal experiments with acrolein.) Arch. Hyg. 73:331-9, 1911.

Cats exposed,1 at a time, to acrolein fumes exhibited the following signs: At 0.025 mg./l. for 3 1/2 and 9 2/3 hr., acrolein produced irritation, salivation, licking, lacrimation, nasal discharge and slight narcosis. The animals recovered shortly after exposure. A dose of over 0.04 mg./l. for 4 hr. produced such intense irritating effects on the animal that it took several days for recovery. In addition to the above-mentioned reactions it also manifested nausea; respiratory disturbances were not yet conspicuous. Following 0.2 mg./l. for 2 2/3 hr., the manifestations of pulmonary irritation were distinct; they were apparently painful; the accessory muscles entered into activity. A dose of 1.5 mg./l. injured the animal most severly; it died 18 hr. following 2 1/4 hr. exposure with manifestations of pulmonary edema and and pulmonary hemorrhages. Following 1.98 mg./l., the animal succumbed after 2 1/2 hr. It was clearly apparent that following the higher doses, involving sensations of pain, the distinctly slight narcotic action of the poison manifests itself only vaguely.

610. Lehmann, K. B. and Diem, L.: Experimentelle Studien über die Wirkung technisch und hygienisch wichtiger Gase und Dämpfe. XXX. Die Salpetersäure. (Experimental studies on the action of technically and hygienically important gases and vapors. XXX. Nitric Acid.) Arch. Hyg. 77:311-22, 1913.

10 cats (weight 2-4.5 kg.) and 3 rabbits (weight 1-2 kg.) were exposed to the inhalation of HNO_3 in the air at concentrations (given as mg. HNO_3/l. air) ranging from 0.04 to 0.88 for periods of time ranging from 35 to 335 min., both in various combinations. Both the experimental conditions and the determination methods are described in detail, and the results are tabulated. They may be summarized as follows: the symptoms demonstrated by the experimental animals are not characteristic and do not differ from those caused by the inhalation of other irritating substances, e.g., HCl, SO_3. The rabbits showed less pronounced reactions than the cats. The latter kept their eyes closed and had increased salivary secretion. The initial signs of irritation in the animals were followed by a latent state and, only at higher concentrations, by a second, short state of severe irritation. The subsequent state of numbness and immobility lasted until shortly before death, when the animals showed signs of dyspnea, restlessness as well as convulsions. Death was due to an acute lung affection. Owing to a xanthoproteic reaction, the hair of the light-colored cats became yellow. 3 cats died after 35-120 min. of exposure to a concentration of 0.5-0.73, 2 cats recovered after 90-100 min. inhalation of 0.43-0.50, one cat died the morning after receiving 0.88 for 200 min. Autopsy did not demonstrate any corrosion of the mucosae of the eyes, nose and mouth. The trachea was somewhat hyperemic. Pneumorrhagia as well as pulmonary emphysema and edema were noticed. No distinct signs of methemoglobin could be detected. Concentrations of 0.05-0.1 were tolerated by cats for several hours, whereas that of 0.2 was tolerated for 2.5 hr. but may cause death after 5 hr.

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In 2 humans, 0.03 had an irritating effect on the upper respiratory tract as well as on the conjunctivae and the facial skin for the first 20 min. of an 1-hr. exposure. Then, however, the symptoms did not exacerbate, and the following 40 min. could be tolerated although the inhalation was accompanied by the appearance of a headache which persisted for one hour after the termination of the exposure. An exposure of 2-3 min., with short interruptions, to 0.22 caused in humans frontal headache, a strongly acid taste in the mouth and dryness of the skin of the hands.

611. Lehmann, K.B. and Hasegawa: Studien über die Wirkung technisch und hygienisch wichtiger Gase und Dämpfe auf den Menschen. XXXI. Die nitrosen Gase: Stickoxyd, Stickstoffoxyd, Salpetrige Säure, Salpetersäure. (Studies on the action of technically and hygienically important gases and vapors upon man. XXXI. Nitrous gases (fumes): Nitric oxide, nitrogen dioxide, nitrous acid, nitric acid.) Arch. Hyg. 77:323-68, 1913.

The first problem under investigation was the influence of an equimolecular mixture with HNO_2 on the action of HNO_3 on the organism. (The concentrations given below are mg. HNO_3/l. of air.) 14 cats and 5 rabbits were exposed for periods of 5 min. to 7.25 hr. to inhalation of nitrous gases at concentrations ranging from 0.19 to 9.66 in various combinations. 3 human exposures to the following concentrations are reported: 0.16 for 1 hr., 0.26 ⟶ 0.06 for 2 hr., the decrease in concentration starting after the first 30 min. of the exposure, and finally 0.54 for 10 min.

Whether or not poisoning due to nitrous gases is nitrite poisoning, was examined from the following points of view: a) does HNO_2 remain stable under the influence of O_2, b) does it enter the respiratory tract as such, c) where, when and to what extent can HNO_2 be recovered in the organism after being inhaled or injected?

a) In vitro experiments demonstrated that HNO_2, under the influence of 0.2, is converted to HNO_3. b) $NaNO_2$, $NaNO_3$ and HNO_2 were added to fresh muscles and organs or were introduced into living cats and rabbits by subcutaneous or intraperitoneal injection or by inhalation. One normal rabbit served as control. On analysis shortly after exposure, the recovery of HNO_2 was considerable, but after 30 min. or more, only negligible amounts could be recovered, being located mostly at the site of introduction and the surrounding area.

The experimental results may be summarized as follows: all the nitrous gases act upon the lungs like an equimolecular mixture of HNO_3 and HNO_2 The amounts absorbed by way of the lungs neither produce a general acid poisoning nor a nitrite poisoning. A qualitative absorption of nitrite in all the animal experiments was proved by tests for nitrite on organ extracts. The symptoms observed following the exposure of the animals are more easily explained by the cauterizations found in the respiratory tract which lead to laryngitis, bronchitis, hyperemia, hemorrhages, marked edema and vicarious emphysema of the lungs. The death of the animals must be attributed mainly to pulmonary edema. Only in one instance, methemoglobin formation was noted. There was a pronounced difference between the reactions of animals and man in that the rabbits and cats showed an acute development of pulmonary edema and of general severe condition, while in man, a latent period followed the exposure resembling that observed in brass worker's diseases (ZnO poisoning). The author points out that there are only a few reported cases of human exposures to nitrous gases where this typical latent period was not observed. This latent period makes it difficult to judge, at exactly what concentrations an injurious effect might have been caused. On the basis of the experimental observations, the author concludes that 0.1 mg. of HNO_3 + HNO_2 measured as HNO_3 might be well tolerated by humans for hr.,

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Lehmann, K.B. et al. (continued)
0.2 only for about 0.5 hr., 0.3-0.4 appears to be dangerous, the danger increasing with concentrations of 0.6 and 1.0. As to the effect of the exposures on animals, the following concentrations had these effects: 0.3 was tolerable for 6-7 hr., 0.4-0.5 tolerable for 1 hr., the same concentration being lethal for cats at 2-4.25 hr. 0.7-0.8 was tolerable for 1.75 hr. but lethal in 3-4 hr. 2.0 seems to be rapidly fatal for animals.

612. Haggard, H.W.: The anesthetic and convulsant effects of gasoline vapors. J. Pharmacol. Exptl. Therap. 16:401-4, 1920.
Dogs were exposed to a stream of air containing gasoline vapor in concentrations of 0-250 ppm for 0-70 min. 1 dog each was used for "Standard" gasoline, "Socony" gasoline and "good Gulf" gasoline. Signs of discomfort appeared at ca. 75 ppm, convulsions occurred at ca. 100 ppm and immobility at 175 ppm. It is noted by the author that in general gasoline vapor has an anesthetic action somewhat like that of ethyl ether but with marked convulsant effects due doubtless to irritation of the cerebral cortex. Thus the stage of excitement, common in ether anesthesia, is marked by convulsions under gasoline vapor. The stage of full anesthesia, between consciousness and death, is very narrow.

613. Blumgart, H.L.: Lead studies: VI. Absorption of lead by the upper respiratory passages. J. Ind. Hyg. 5:153-8, 1923.
Previous reports in the literature on the deposition and absorption of Pb in upper air passages are reviewed. Though various experiments on absorption of antitoxins through the nasopharynx had been done, the possibility of swallowing or absorption of Pb through the trachea was not ruled out. Only nasal absorption of pitruitin had been established. In this experiment nasal absorption of $PbCO_3$ dust in 2 cats and 2 dogs was investigated. Both the trachea and esophagus were occluded by ligatures, after insertion of a tightly-fitting cannula in the trachea below the thyroid. Then the $PbCO_3$ dust was carefully sprayed into the nose with a nasal atomizer, the amount being determined by weighing the atomizer before and after use. The animals did not survive the operation well and died after 18-36 hr. Each animal was carefully autopsied and the skeleton, lungs, trachea and esophagus, liver, muscle and internal organs were analyzed for Pb. In all cases no more than a trace of metallic Pb was found in the lungs, esophagus and trachea, indicating that the ligatures were effective in preventing the passage of Pb, and a trace-1.3 mg. Pb were found in the liver, muscle and internal organs. 22.3-29.3 mg. Pb were found in the skeleton of 3 of them; only 7.5 mg. were found in the 1st case probably due to loss of Pb in the analysis. It is realized that these experiments do not reproduce the situation in industry for the exposure was sudden and to a relatively large amount of dust at one time. Also some of the Pb was probably lost in the drooling following the operation. However, it is concluded that the experiments demonstrated a rapid absorption of relatively insoluble Pb particles from the upper air passages sufficient to induce plumbism readily by this portal of entry alone. Absorption in industry of Pb salts by this route would therefore seem to be a definite possibility.

614. Horvath, A.A.: The action of ammonia upon the lungs. Proc. Soc. Exptl. Biol. Med. 22:199-200, 1924.
Six rabbits and 16 guinea pigs were exposed continuously to constant concentrations of 1.5, 0.5, 0.25 and 0.15 cc. gaseous NH_3/l. air until

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Horvath, A.A. (continued)
natural death or autopsy. 3 rabbits and 11 guinea pigs died spontaneously; the rest were killed. A rise in temperature, to a maximum of 0.3 - 2.5°C. above normal, occurred in the animals exposed to concentrations >0.15% NH_3. This rise was usually more noticeable about the middle or toward the end of the exposure. The clinical signs indicated pneumonia. Autopsy and microscopic study showed chiefly catarrhal bronchopneumonia, associated in some cases with fibrinopurulent pleuritis and pericarditis. Lower % concentrations more often caused pleuralpneumonia, and higher %'s only catarrhal bronchopneumonia. Rabbits were less sensitive than guinea pigs. The latter were able to tolerate 0.15% NH_3 for a mo. without visible external disturbance or apparent macroscopical changes in the lungs at autopsy; but at 0.25% NH_3 gas in the chambers, lesions in the lungs of guinea pigs were noticed. The author also discussed the pathological picture in lungs produced by NH_3. When injecting NH_3, the normal metabolism of NH_3 is disturbed and the liberated NH_3 gives the resulting pathological picture of anaphylactic shock in the lungs. The author had further found that adaptation for NH_3 gas, as described by Lehmann and Seifert, does not exist.

615. Murphy, J.B. and Sturm, E.: Primary lung tumors in mice following the cutaneous application of coal tar. J. Exptl. Med. 42:693-700, 1925.

36 applications of tar extracted from coke residue were made at 12 separated areas on the surface of each of 80 mice in 3 experiments over a period of 83 days. The applications, made in such fashion that no single area was irritated sufficiently long to cause lesions of the skin, resulted in a very high incidence of lung tumors. This incidence ranged from 60% in 1 experiment to 78.3% in another. A total of 38 control mice from the same stock but from 3-6 months older, and for that reason the more liable to spontaneous lung tumors, failed to show a single instance of such growths. Even in a stock in which spontaneous lung tumors had been frequent, the incidence for corresponding age periods has never been above 5.5% while the average has been between 1-2% over a period of yr. The tumors in the tar-painted animals occurred as small white nodules, either single or multiple. They were typical epithelial neoplasms, identical histologically with those described by previous authors as occurring spontaneously in mice. Some possible factors in the causation of the tumors, i.e., that tar particles get into the lungs through the lymphatics or that the tar painting so alters the body state that tumors occur at points of incidental irritation in lungs where under ordinary circumstances they would not develop, are briefly discussed. The authors believe the latter possibility the more likely.

616. Sayers, R.R., Fieldner, A.C., Yant, W.P. and Thomas, B.G.H.: Experimental studies on the effect of ethyl gasoline and its combustion products. U.S. Bur. Mines Report, 1927, 447 pp.

This investigation was carried out in 3 parts. The 1st was physiological effects of exhaust gases from engines using ethyl gasoline and was divided into parts a) using gasoline containing the commercial amount of ethyl fluid and b) using gasoline containing 5 times the commercial concentration of Pb tetraethyl. In both cases monkeys, dogs, rabbits, guinea pigs and pigeons in 2 groups were exposed to the exhausts for 3 hr./day, 6 times/wk. and to 6 hr./day, 5 1/2 times/wk., respectively. The a) experiment lasted 8 mo. from Dec. 6, '23 - July 26, '24. The average CO concentration was 0.010-0.020% by volume, and the average Pb dust concentration was 0.0004 mg./ft.^{3} air or 2.5% total Pb using a long exhaust pipe (Dec.6-Apr.5) and 0.0041 mg./ft.^{3} or 25.6% using a short

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exhaust pipe (Apr.6-July 26). In only 2 cases was distinct Pb storage found, i.e., 0.190 and 0.094 mg./100 g. body weight in a rabbit and guinea pig, respectively. No distinct pathological lesions attributable to Pb poisoning were found and the blood picture was comparable to the controls. No symptoms from Pb poisoning were observed; the animals, with the exception of a few in a group who had symptoms of intercurrent disease, were healthy, lively and had good appetites. The b) experiment lasted from July 28, '24 - Aug. 28, '25. The average CO concentration was 0.008, 0.015% by volume, and the animals breathed in an average 0.040 mg. Pb/ft.^{3} air or 50% of the Pb added as fuel. There was distinct storage of Pb in all species with the amount/100 g. body weight decreasing in the order of pigeons, guinea pigs, rabbits, monkeys and dogs, i.e., in order of size. In general, the accumulation increased with total period of exposure. The concentration used was close to the threshold concentration for all except the pigeons (when it was above), for some animals of each group showed little or no storage while others showed a distinct storage. The outstanding pathological finding due to Pb in guinea pigs and pigeons was a degeneration of the liver; in dogs and rabbits it was a degeneration of the convoluted tubules of the kidneys and glomeruli with serous exudate in the glomerular space. There was none in the monkeys. The blood was normal for all the species. No characteristic symptoms of Pb poisoning were obtained, except loss of weight in some animals that was due to other causes than Pb poisoning. Weight and growth was normal, except for pigeons in the latter part of the experiment. The concentration of Pb breathed was 2 1/2 times the concentration that theoretically could be produced by using commercial ethyl gasoline. The threshold concentration of Pb thus lies between 0.004 mg./ft.^{3} and 0.04 mg./ ft.^{3}, and this agrees with Legge's 0.5 mg./m.^{3} or 0.014 mg./ft.^{3}. Tests on men breathing exhaust gases from ethyl gasoline show that, on the average, 87% of the inhaled Pb dust was again exhaled, leaving only approximately 13% retained in the lungs and respiratory passages.

The 2nd part was concerned with the effects of inhaled, unburned ethyl gasoline and other motor fuel vapors. The fuel vapors used were a) straight gasoline, b) ethyl gasoline, c) gasoline containing 2 1/2, 3 3/4 and 5 times the commercial concentration of $Pb(C_2H_5)_4$ and ethylene dibromide (ethyl fluid), d) gasoline containing 5 times the commercial concentration of ethylene dibromide only, f) benzol-gasoline blend and g) motor benzol. Vapor concentrations used were 1.0% for 1 hr., 0.3% for 2 hr. and 0.1% for 3 hr. Guinea pigs were exposed to all vapors in all concentrations. Monkeys, dogs and rabbits were exposed to 0.3% for 2 hr. of both a) and b). Storage of Pb in control guinea pigs, rabbits and monkeys was 0.05, 0.01 and 0.000 mg. Pb/100 g. body weight, respectively. Pathological findings on death of unexposed control rabbits revealed peritonitis and systemic infection following injury or subcutaneous infection and lung infection; in control guinea pigs cause of death was usually lung infection. Only symptoms of intercurrent disease were noted in the controls. In animals exposed to gasoline, Pb storage was similar to that in the controls. The general pathological findings in all concentrations were hyperemia of the lungs, granular degeneration of the liver and of the kidneys, leading to pitting and scarring, especially in rabbits. The usual findings for guinea pigs were acute granular degeneration of the liver, pancreas, adrenals and heart muscles and a slight degeneration of the endothelial lining of the glomerular capillaries. The blood changes were minor and insignificant. The symptoms at 0.3% were unsteadiness, drowsiness and moderate

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watering of nose and eyes due to irritation; they disappeared shortly after exposure. Weight and growth were normal. In exposure to b), c), d) and e) some animals exposed to 0.1% showed distinct Pb storage. Nearly all monkeys, dogs and rabbits exposed to 0.3% and guinea pigs to 0.3% showed Pb storage. The pathology was similar to that found in gasoline exposed animals and no significant hematologic changes were found. No characteristic symtoms were noted in exposures to 0.1 and 0.3% of b). Exposure to 1.0% caused depression at times. Guinea pigs exposed to vapors of c) showed depression, malaise, mild to marked nervousness, excitability, tremor, a few cases of partial paralysis and early death. Frequency of occurrence and severity of symptoms increased with amount of ethyl fluid and concentration of vapor. Guinea pigs exposed to d) and e) had the same type of symptoms. Weight and growth were undisturbed in animals exposed to 0.1 and 0.3% of b). 1.0% of b) inhibited growth, as did all concentrations of c) with the ethyl fluid increased 2 1/2 times. 1.0% of this caused marked loss of weight. C) with the ethyl fluid increased 3 3/4 - 5 times caused increasingly more severe effects. Symptoms from exposure to d) and e) were the same as c) with 5 times the ethyl fluid. The pathological findings in animals exposed to f) were acute degeneration of liver and kidneys, anemia of the spleen, congested adrenals and hyperemia of the lungs, and edema in lungs of animals that died after exposure to 1.0% vapors. These findings are similar to those for gasoline alone. The number of white cells and hemoglobin content were normal; red cells showed tendency toward polycythemia. 0.1% vapors caused no symptoms, except slight watering of eyes and drowsiness in guinea pigs. 0.3 and 1.0% caused distinct nose and eye irritation, drowsiness and unsteadiness, and death occurred frequently. Only 1.0% vapors caused inhibition of of growth. Exposure to g) caused degeneration of liver and kidneys, anemic spleen, congested pancreas and adrenals, congestion of lungs and an edema from 0.3 and 1.0% exposures. There was a slight increase in red cells and moderate polychromatophilia. Symptoms included temporary drowsiness, dizziness and watering of eyes and nose. 1.0% vapors caused an unconscious or semiconscious state at the end of 1 hr. Animals were susceptible to colds and pneumonia. Slight to distinct inhibition of growth occurred from 0.1-0.3-1.0% exposure. The Pb concentrations in the vapors in these experiments were the same as in the liquid. Therefore, exposures were greater than normal since in ordinary evaporation of ethyl gasoline usually only a very small portion of Pb accompanies the 1st 10-20% of the evaporated liquid. A limited number of determinations at filling stations showed the usual prevailing concentration of gasoline vapor in air to be 0.01-0.03% and only momentary concentrations of 0.1%. Exposure of men to 0.1% gasoline vapor caused mild symptoms of dullness, unsteadiness and giddiness in 50 min.; to 0.3%, slight irritation of the eyes, moderate dizziness in 30 min.; at 0.7%, coughing, marked eye and nose irritation, numbness in legs and unsteadiness in 10 min.

Effects of ethyl gasoline when absorbed through the skin were studied in part 3. In some of these the animals were not only exposed through skin absorption but also by ingestion and inhalation. Effects were greater then.

617. Smith, R.E.: The etiology of primary lung carcinoma: An experimental and clinical investigation. J. Cancer Research 12:134-42, 1928.

Twenty mice were exposed to coal tar vapor, from heating coal pitch above 346 C., for 6 hr./day, 5 days/wk. for 3 mo. and then for 6 hr./day, 3 times/wk. The total number of hr. of exposure ranged 132-409. 617 g. of tar were used that left 125 g. residue. 26 mice were exposed to the exhaust fumes from a Ford engine for 2 min. at a time, 3 times/day at intervals of ca. 2 hr. Total length of exposure ranged 2-368 hr. As the length of exposure increased, there was a progressive deposition of C in the lungs in a more or less even distribution, mainly in the large bronchi but also in the alveoli. 6 drops of gasoline were applied to the backs of 29 mice 3 times/wk. for ca. 5 mo. Though most of the hair on the back fell out, the animals thrived. An epidemic of mouse typhoid broke out in the controls, and only 30 controls lived on an average of 55 days from the beginning of the experiment. At autopsy none showed any neoplastic changes. In the coal tar experiment none of the 20 mice developed tumors; in the exhaust gas experiment 1 out of 26 (3.8%) developed a lung adenocarcinoma and in the gasoline painting experiment 1 out of 29 (3.4%) developed a lung adenocarcinoma. The post-mortem findings are tabulated for each case. It is concluded that the irritants used for the period stated did not have any injurious effects. A study of 48 cases of primary human lung carcinoma proved by autopsy was made. The variety of occupations and history of previous diseases are considered. The study did not reveal any definite etiological factor.

618. Flury, F.: Die Rolle des Stickstoffmonoxyds bei der Vergiftung durch nitrose Gase. (The role of nitrogen monoxide in poisoning by nitrous fumes.) Verhandl. Deut. Pharmakol. Ges. 1930, pp. 104-6.

On the basis of both reported clinical experience and results from animal experiments, the following types of poisoning due to nitrous fumes may be distinguished. 1) Poisoning due to irritant gases (e.g., phosgene): initial symptoms of varying severeness are followed by a latent state. Then pulmonary edema leads to death, in most cases after 1-2 days, sometimes within a few min. or hr. This is the type of poisoning most frequently encountered. 2) Reversible type: immediate acute symptoms lead to death unless removal from the poisonous atmosphere is possible. In the latter case, fast recovery takes place. No pulmonary edema is present in this type. 3) Shock type: acute symptoms lead to immediate death due to stasis of the lung circulation. This type is caused only by sudden inhalation of very high concentrations of nitrous fumes. 4) Combined type: immediately occurring cerebral symptoms seemingly disappear for several hr. following the removal from the exposure. After this latent state, however, pulmonary edema leads to death. These differences are due partly to the varying degrees of resistance of the individual organisms,and partly to the quantitative and qualitative differences in the inhaled gas mixtures. Even in cases of "pure nitrous poisoning," a mixture of gases has been inhaled: NO, NO_2, N_2O_4, nitric and nitrous acids in both gaseous and vaporous states, and also N_2O when a yellow flame is present. A change of conditions brings about a shifting in the equilibrium of gases in a mixture. It is shown that the reaction of $2NO+O_2=2NO_2$ is not instantaneous, as is usually claimed, but that it takes place in a measurable period of several seconds. In both humans and animals, the symptoms following exposure vary greatly depending on the distance of the exposed subjects from the source: near the escape of the gas, they are typical of NO poisoning, while exposure at a greater distance produces symptoms

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Flury, F. (continued)
characteristic for NO_2 poisoning. This theory was illustrated by the exposure of white mice close to an air flow (velocity 10 l./min.) to which pure NO was added. The animals exposed to the air mixture in which oxidation of the NO has not yet taken place showed the following symptoms: cyanosis, dyspnea, paralysis and convulsions. These effects quickly disappeared in fresh air. When mice were placed at a greater distance from the source of NO, they showed signs typical of NO_2 poisoning, such as local irritation, followed by a latent state of varying duration, then death due to pulmonary edema. Methemoglobin was present in all animals. In substance, these effects are summarized as typical for NO poisoning: no local irritation, faster action, regression of symptoms after termination of exposure. Its effects on the central nervous system are compared with those of CO inhalation.

619. McDonnell, H.B.: Experiments with ozone on guinea pigs at the James Todd Laboratory of the University of Maryland. J. Assoc. Official Agr. Chem. 13:19-34, 1930.

Seven experiments are reported in which 580 guinea pigs, half inoculated with tuberculous germs and half uninoculated, were exposed to various concentrations of O_3 ranging from 1.04-0.1 ppm. In 2 experiments, O_3 was supplied from 4 different cells whose electrodes differed as to size, form and material, i.e., corrugated Fe (3x7"), Al, mattress type (5x7"), corrugated Al (5x7") and corrugated Al (7x10"). In the 1st of these, pneumonia played havoc with the pigs and no satisfactory results were obtainable. In the 2nd, all the uninoculated animals exposed to O_3 supplied from the cell with the Al, mattress type electrodes survived the experiment. The other uninoculated pigs showed better than 50% survival. As in all the experiments, all the inoculated pigs died from pneumonia by the end of the experiment, which usually lasted 14-18 wk., and the controls showed 90-100% survival. In the other experiments, mortality in the uninoculated animals increased in approximate proportion to the amount of exposure to O_3. Even at 0.1 ppm O_3, though 9 out of 10 pigs survived 18 wk. exposure, i.e., the same % as the controls, 2 more died in the 18 wk. following removal from exposure. The results of each experiment are graphed. It is concluded that O_3 is extremely poisonous when inhaled at higher concentrations because it acts on the mucous membrane and forms a froth, which, at 1 part O_3/1000 air by weight, will cause the death of guinea pigs in a short time by filling the lungs and cutting off the air supply. In lower concentrations, down to a few ppm, pneumonia often develops, causing death sooner or later, depending on the concentration. O_3 given continuously in the respired air for several mo., in concentrations even less than 1 ppm, by weight, apparently shortens the lives of guinea pigs, whether tubercular or disease-free, by irritating the lungs and bronchial tubes and causing pneumonia. The highest concentration that is harmless has not been worked out.

620. Schabad, L. M.: Studien über primäre Lungengeschwülste bei Mäusen und ihr Verhalten zum Steinkohlenteer als cancerogenem Faktor. (Studies on primary lung tumors in mice and their reaction to coal tar as cancerogenic factor.) Z. Krebsforsch. 30:24-59, 1930.

The incidence, morphologic and histogenic characteristics of primary lung tumors in mice receiving skin applications of coal tar were compared with those of spontaneous primary lung tumors in mice having died of various diseases at ages up to 29 mo., and those obtained in 1 generation of mice skin-treated with mustard. Among 228 mice receiving no coal tar, 8

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Schabad, L.M. (continued)
developed primary lung tumors. Among 107 mice of the same pure strain that received skin applications of coal tar 2-3 times/wk., for 6-8 mo., 50 were started on experiment at age of 4 mo., 27 at age of 6 mo., 20 at age of 7-8 mo. and 10 at age of 12 mo. 22 of them developed primary lung tumors (3 of them malignant), appearing at ages of 12.5-24 mo. Among 114 mice of the 2nd-4th generations, a total of 57 developed primary lung tumors of the following types: 49 cancroid, 4 with metastases, 8 specific precarcinomatous lesions, at ages 9-10 mo. All tumors appeared after termination of exposure; nearly all were primary. They are described as round, gray-white nodules, sizes ranging from 1 mm. diameter to covering the lower lung lobes. Their tissue was either clearly outlined against the surrounding lung tissue or plainly infiltrating it; sometimes, there was a gradual transition. Sudan III analyses revealed fatty degeneration in only the large tumors, distinct visibility of cancerous stroma and its close connection with the elastic pleural tissue. The majority of tumors originated in the alveolar epithelium of the large bronchi.

The investigation has demonstrated that the cancerogenous action of the tar had produced a predisposition for the development of pulmonary tumors in the experimental mice, although the application of the substance was not done by way of inhalation. The predisposition was hereditary, even when one generation was not treated with tar but with mustard, a non-cancerogenic substance. It increased in the following generations.

621. Haynes, F.: Experimental dust inhalation in guinea pigs. J. Hyg. 31:96-123, 1931.

A historical review of the literature on animal dust exposure studies is given. In his own investigations, groups of 12 guinea pigs (in 20 experiments) were exposed to a cloud of 140 cc. dust for 2 hr./day for 2 wk. (total-24 hr.). The times of exposure varied somewhat for 5 of the experiments. The animals appeared to suffer little, if any, discomfort, though the cloud was thick. 2 guinea pigs were killed, with $CHCl_3$, shortly after exposure, 2 others 2-6 wk. later, and the remainder at variable intervals. In very few cases, did autopsy reveal any pathological condition of the abdominal viscera. Sections of both lungs were taken at the level of the bifurcation of the trachea and at the middle of each lobe. The controls were of all ages and were quite healthy. The author summarizes the results as follows. "The following dusts produce a fibrosis in the guinea pig's lung, and are therefore to be classed as dusts whose inhalation in industry would be attended by risks of pneumoconiosis. The most deadly of all dusts examined was precipitated SiO_2. Less dangerous, but all producing fibrosis, were the following, arranged in order of decreasing toxicity: flint, slate, Al hydroxide, precipitated chalk, Mg carbonate and carborundum. In the concentrations used in the experiments calcspar and emery were borderline' dusts, indicating that their inhalation in any considerable quantity would cause fibrosis. Wood charcoal inhaled in large amount produces a slight fibrosis, and must, therefore, be placed on the "dangerous" list. Colloidal coal, when inhaled in massive amounts, is potentially dangerous, while shale under similar conditions is rather more dangerous. Hematite, talc and molecular mixtures of soluble SiO_2 with Al hydroxide and Mg carbonate, respectively, were not found to cause any permanent lesions in the lung." The probable mechanism of dust irritation and elimination and of formation of fibrosis in the guinea pig's lungs is described. It is further concluded that heavy inhalations of any dust are liable to cause pulmonary damage, and the intensity of the initial pulmonary reaction to a dust is very generally in inverse ratio to the degree of eventual damage caused by the dust.

622. Vedder, E.B. and Armstrong, G.C.: The toxicity of sulfur dioxide. War Department, Chemical Warfare Service, Report E.A.T.R. 149, 1933, 55 pp.

In this report the median lethal concentrations of SO_2 on several experimental animals and the effects of this gas upon animal life and health when breathed in low concentrations over long periods of time were determined. 2 rabbits, 2 guinea pigs, 4 white rats and 10 white mice/experiment were exposed to various concentrations of SO_2, ranging from 100-600 ppm, for 24 hr. 5 white mice/experiment were exposed at various concentrations, up to 500 ppm, for 10, 60 and 360 min. The median lethal concentrations (MLC) and the surely fatal concentrations (SFC) of SO_2 are shown in this table.

Animals	Exposure	MLC		SFC	
		ppm	mg./l.	ppm	mg./l.
rabbits	24 hr.	255	0.67	385	1.01
guinea pig	24 "	404	1.06	530	1.39
white rat	24 "	404	1.06	480	1.26
white mouse	24 "	130	0.34	200	0.52
" "	10 min.	1350	3.54	1750	4.58
" "	60 min.	610	1.60	850	2.23
" "	360 min.	340	0.89	550	1.44

White mice, rats and rabbits were also exposed for 6 hr./day for 15 days to ca. 25 ppm SO_2. No deaths which could be ascribed to the effects of SO_2 occurred. These same species were also exposed at 6 hr./day for 30 days to ca. 50 ppm SO_2. No deaths occurred among the rats, but did occur among the white mice and rabbits. These experiments were intended to simulate conditions in industrial plants where SO_2 exposure to workmen occurs. The following reactions of the animals in the exposure chamber were noted: blinking, progressive dyspnea, cloudiness of vision (except in the short exposures of the mice) and progressive inactivity. Autopsy findings revealed that the eyes, the cornea in particular, were affected in rabbits, guinea pigs and rats, the lungs in all showed varying degrees of congestion, emphysema, and/or edema and the kidneys and liver in all were normal. 30 white mice, 16 rats, 6 rabbits and 10 guinea pigs/experiment were continuously exposed to low concentrations of SO_2 over long periods of time. The data and results, contained in the following table, shows that concentrations as high as 0.026 mg./l. (10 ppm) were not injurious to animals exposed to it for 90 da.

Concentrations		Duration	Temp.	Rel. Humidity	Results
mg/l.	ppm	days	°F.	%	
.008	3.05	16	70	40	No deaths and no symptoms
.0092	3.51	77	70	40	No deaths due to SO_2
.0173	6.60	90	70	40	" " " " "
.0262	10.006	90	70	40	" " " " "
.026	10	53	70	60	" " " " "

The foliage of vigorous plants was destroyed by exposure to 6.6 ppm SO_2 for 24 hrs.

623. Campbell, J.A.: Cancer of skin and increase in incidence of primary tumours of lung in mice exposed to dust obtained from tarred roads. Brit. J. Exptl. Pathol. 15:287-94, 1934.

Mice were exposed to a cloud of road dust for 10 min. periods 4-6 times/day at hourly intervals, 5 da./wk. The dust contained ca. 2% tar and it is estimated that each mouse received only 1-2 mg. tar/day. In the 1st experiment 85 mice were gradually acclimatized over a 3 mo. period to breathe 0.20-0.30% CO and then they were exposed to dust for 240 da. During this period, every night and on Saturdays and Sundays they were also continually exposed to 0.20-0.30% CO. In the 2nd experiment 73 mice were

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Campbell, J.A. (continued)
exposed only to dust for 255 da. 134 mice were used as controls. The road dust contained, besides the tar, portions of the road metal and building materials, dust from dried leaves, animal excreta, oils, etc., from vehicles on the road. On the 537th day of the experiment, 25% of the control mice were alive as compared to ca. 6% of the experimental mice. In the 1st experiment the 1st wart appeared on the 248th day or after 180 days of actual dusting and in the 2nd experiment it appeared on the 186th day or after 133 days of actual dusting. Typical tar cancer of the skin developed at or near the site of most of the warts in 45% of the 44 mice in the 1st and in 70% of the 56 in the 2nd that survived to the time of appearance of the warts. This suggests that the breathing of CO retards the effects of dusting, i.e., the growth of tumors. Dust was spread throughout the lungs but there was surprisingly little inflammatory reaction either in the lungs or lymph tissues. There was a great increase in primary lung adenoma in the dusted mice; the tumors varied from the confined type to the malignant invading type.

624. Machle, W., Thamann, F., Kitzmiller, K. and Cholak, J.: The effects of the inhalation of hydrogen fluoride. I. The response following exposure to high concentrations. J. Ind. Hyg. 16:129-45, 1934.

White rabbits 4-6 mo. of age (1800-3900 g.) and mature guinea pigs (500-1300 g.) were used in this study. Groups of 3 rabbits and 3 guinea pigs were exposed to HF in concentrations of 8-0.024 mg./l. for periods ranging from 5 min. to 41 hr. Evidences of respiratory irritation were noticeable in all animals at all concentrations though for those animals exposed to ≦0.05 mg./l. concentrations they were quite mild and not of immediate onset. Slowing of the respiratory rate was uniform and particularly noticeable in rabbits. Weakness and appearance of illness were prominent in all animals exposed to 0.5 mg./l. for ≧15 min. Rabbits escaping bronchopneumonia and death returned to normal appearance and activity in a few days to a few wk. while guinea pigs showed a definite tendency to delayed response and death between the 5th and 10th wk. following exposure. The general pathologic findings were: injury to cornea and nasal mucous membrane, cardiac dilation with congestion and myocardial injury, pulmonary hemorrhage, congestion, emphysema and edema, with bronchopneumonia in many instances, hepatic congestion with varied evidences of parenchymal injury, splenic congestion and edema, renal congestion and edema of other organs. On the basis of findings it is concluded that exposure to concentrations of HF above 1.5 mg./l. for any period of time is dangerous for rabbits and guinea pigs. Concentrations of 1.0 mg./l. and less caused no deaths in animals exposed as long as 30 min. although evidences of injury were definite. Concentrations below 0.1 mg./l. were tolerated for 5 hr. without injury severe enough to produce death. No deaths occured in 6 animals exposed to 0.0245 mg./l. for 41 hr. The highest concentration that 2 men tolerated for >1 min. was 0.1 mg./l. Even at this level there was definite smarting of the exposed skin in <1 min., conjunctival and respiratory irritation was marked but bearable, the taste of the gas pronounced. At 0.05 mg./l, smarting of the skin was no longer noted, conjunctival irritation was definite, nasal irritation quite marked. Tickling and discomfort of the larger air passages were noticeable with each inspiration; the taste was definite. At 0.026 mg./l. there was discomfort but the atmosphere could be tolerated for several min. Repeated brief human exposures failed to elicit any tendency toward habituation to this concentration.

625. Robson, W.D., Irwin, D.A. and King, E.J.: Experimental silicosis: quartz, sericite and irritating gases. Can. Med. Assoc. J. 31:237-45, 1934.

Three groups of 25 rabbits each were subjected to daily exposures of gas, gas and SiO_2 dust, and gas and sericite dust (K aluminum silicate) till death or for 40 wk. The gas consisted of NO_2 2:10,000 and SO_2 1:10,000 for 3 hr./day, for the first 3 wk. This was found to be too toxic for the rabbits and so the concentration was lowered to NO_2 1:10,000 and SO_2 1:20,000 for 2 hr./day. The animals died of acute pneumonitis after periods of 2 da. to 40 wk. at almost the desired intervals. Histological sections were made on the portions of lung not involved by pneumonitis in each animal. The pathological findings in each group are described in detail. Exposures to the dilute irritating gases produced degenerative lesions in the lungs and predisposed to pneumonitis. Exposure of rabbits to dilute irritating gases combined with sericite dust for 40 wk. did not produce fibrotic changes in the lungs. The dust was present in a patchy distribution for the most part in alveolar phagocytes, but also to a slight extent in the lymphatic aggregations and mediastinal lymphatic glands. Exposure of rabbits to dilute irritating gases combined with SiO_2 dust gave rise to an acute pulmonary silicosis, characterized by typical siliceous fibrotic nodules first in the alveoli (in 10 wk.), secondly, in the lymphatic aggregations (in 10-13 wk.) and thirdly, in the lymphatic glands (in 13 wk. or more). The dust was distributed diffusely throughout the lung, a high % being contained in alveolar phagocytes.

626. Barrett, H.M.: The antirachitic effect of ultra-violet radiation transmitted by a smoky atmosphere. J. Ind. Hyg. 17:199-216, 1935.

Albino rats were fed a rachitic diet for 5 wk. and then exposed to the emission of a quartz Hg arc for 10 min./day for ca. 30 da. The rays from the lamp traversed a box, glazed top and bottom with vita glass, into which known concentrations of smoke, with particle size ranging from 0.5-2μ, were introduced. The relationship between the intensity of the Tyndall beam and smoke concentration was determined. For 10-min. periods, the smoke concentration averaged ca. 0.813 mg./l. Some of the animals were irradiated through known concentrations of smoke, some irradiated through the empty smoke chamber and the controls given no irradiation at all. The degree of rickets in the animals was determined by bone ash determinations of the hind legs and roentgenograms of the right hind leg. The difficulties encountered in both the physical and biological assay of energy sources are discussed. The bone ash average of the rats irradiated through the empty box ranged from 34.3-41.2; while the average for those irradiated through smoke ranged 28.6-31.9 and for the control rats it ranged from 22.1-34.5. X-rays showed more complete healing of rickets in the 1st case, slight healing in the 2nd case and severe rickets in the controls. From this it is concluded that irradiation from the quartz Hg lamp, after passage through a concentration of smoke similar to that encountered in the average urban atmosphere, fails to prevent the development of rickets in rats fed on a rachitic diet.

627. Findeisen, W.: Über das Absetzen kleiner, in der Luft suspendierter Teilchen in der menschlichen Lunge bei der Atmung. (Deposition in the human lung, during breathing, of small particles suspended in the air.) Pflügers Arch. ges. Physiol. 236:367-79, 1935.

In this study of the factors influencing the deposition of particles or droplets of inhaled aerosols on the walls of the tracheobronchial tree, the anatomic conditions of the tract, the respiratory process and the

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Findeisen, W. (continued)
sizes of particles or droplets have been schematized, without changing the order of magnitude or the proportions, which is illustrated in numerous figures and graphs. 4 factors, in combined action, cause the deposition of the particles or droplets: a) the brownian movement, b) sedimentation, c) inertia and d) the marginal effect ("Randeffekt"). a) The change of position of an aerosol particle caused by molecular movement of the air is an important factor in the deposition of small, but not of larger particles in air passages with a small diameter. b) There are great variations in the sedimentation rate within the bronchi and bronchioli, depending on the following factors: speed of both fall of particles and of droplet flow, diameter of the air passages as well as their position in relation to the horizontal, i.e., the less inclination, the more sedimentation. c) The effect of inertia is particularly evident at all bifurcations. d) The marginal effect depends on the ratio particle diameter:tube diameter; it is described as insignificant. The combined action of a) and b) causes particle deposition on the walls of the air passages, that of b) and c) results in their deposition at the bifurcations. On the basis of the above considerations, the path of an inhaled aerosol was "observed" from trachea to the sacculi alveolarii and back, and the deposition rate was calculated. These theories then were tested as follows. By spraying salt solution, a vapor with known particle sizes and frequencies was produced which then was sucked (at normal respiratory rate) through the fresh tracheae and lungs of dogs, calves and sheep. Quantitative analysis of the vapor by means of glass wool filters, before and after aspiration, gave results closely corresponding to those calculated above. Thus, with known particle size and distribution, the fate of inhaled aerosol particles can be predicted. Particles of the following size (radius) are deposited at the sites indicated: >30 µ, trachea; 10 µ, bronchioles; 1 µ, sacculi alveolarii. Particles are again expelled with expiration at the following rate: 1µ, 2.6%; 0.3-0.1µ, 65.0% and 0.03µ, the majority (% not stated).

These findings provide significant indications for the choice of therapeutic vapors in inhalation treatment of certain diseases of the respiratory tract and the lungs. A vapor with a particle size of 10µ should be administered in case of bronchial diseases, while in order to affect the alveoli, the particle size of the vapor to be inhaled should be 1µ.

628. Machle, W. and Kitzmiller, K.: The effects of the inhalation of hydrogen fluoride. II. The response following exposure to low concentrations. J. Ind. Hyg. 17:223-9, 1935.

Five rabbits, 3 guinea pigs and 2 Rhesus monkeys were exposed to 0.0152 mg. H_2F_2/l.for 6-7 hr./day, 5 da./week for 10 wk., or a total of 309 hr. 8 rabbits, 5 guinea pigs and 1 monkey were used as controls. There was no pronounced response following introduction of the animals into the exposure chamber, only a slight lacrimation. 2 guinea pigs lost weight after 134 and 160 hr. exposure, respectively, and died after removal from exposure; all the other animals survived exposure without evidence of injury. The death of 2 of the 3 guinea pigs apparently as a result of injury during the exposure period indicates that this animal is more susceptible to H_2F_2, at the concentration employed, than is the rabbit or monkey. Blood counts showed a significant decrease in the number of erythrocytes in the exposed rabbits and monkeys as compared to the controls and a significant increase in leukocytes in the monkeys. Necropsies were performed on 3 guinea pigs, 4 rabbits and 1 monkey exposed to H_2F_2 and on 7 control rabbits 11-12 mo. after initiation of exposure. Damage occurred in the lungs, livers and kidneys of exposed animals, with varying degree,

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Machle, W. et al. (continued)
location and type of damage in the different animals. The lungs and liver were most severely and consistently affected, excepting the 1 exposed monkey. The persistence of typical lesions in the organs many months after cessation of exposure and the persistent blood changes suggest the possibility of the presence of stored F-containing compounds.

629. Campbell, J.A.: The effects of exhaust gases from internal combustion engines and of tobacco smoke upon mice, with special reference to incidence of tumors of the lungs. Brit. J. Exptl. Pathol. 17:146-58, 1936.

Thirty-eight F and 37 M mice were exposed for 7 hr./day, 5 da./wk. from about the age of 3 mo. until their death to exhaust gases from each of 2 internal combustion engines, 1 consuming regular gas and the other ethyl gas. The average CO concentration from exhausts from the regular gas was 0.05^{-}% in the morning and 0.05^{+}% in the afternoon. Very little exhaust C (soot) was present in the chamber. There was no material difference in death rate, body weight and rate of growth between the experimental mice and the controls. There was little difference in the incidence of primary lung tumor. CO concentration from exhausts from ethyl gas was ca. 0.01% in the morning and 0.03^{-}% in the afternoon. The presence of Pb could not be demonstrated. The experimental mice showed an increase in the incidence of primary lung tumor over the controls. 74 mice were exposed to unfiltered cigarette smoke. It is estimated each mouse came in contact with at least 40 mg. tar/mo. There was no important effect upon death rate, body weight or rate of growth of mice. 17 experimental and 11 control mice developed primary lung tumors. The increase in the incidence of primary lung cancer in the latter 2 experiments is considered insignificant, especially at the age of the animals.

630. Seelig, M.G. and Benignus, E.L.: Coal smoke soot and tumors of the lung in mice. Am. J. Cancer 28:96-111, 1936.

This study was undertaken with the purpose of determining whether there exists any relationship between the inhalation of coal smoke soot and the development of carcinoma of the lung in white mice. The results of experimental work on this problem, as reported in the literature, are conflicting. These results are reviewed and an experiment is set up to determine whether or not the soot deposited out of coal smoke plays a role in lung tumor development in white mice. The soot, obtained by burning Kentucky bituminous nut coal, was used as bedding material for the mice. It contained 5% tarry matter. Two or 3 times/day the cages were violently shaken to produce an extra cloud of dust. 100 3-mo. old mice of a tumor-resistant strain were subjected to this atmosphere for 18 mo. and 50 were kept as controls. The amount of soot in the lung increased with time up to 3 mo., after which it remained, in general, the same. The distribution was intrabronchial, intra-alveolar and interstitial, and the soot particles, for the most part, lay free, though there was also an appreciable amount of soot incorporated intracellularly. 20% of both the experimental and the control group had died at the end of 6 mo., 60% of each group at the end of a year and all the mice at the end of 18 mo. 8 of the experimental group (8%) developed adenocarcinoma of the lung, whereas only 1 of the controls (2%) developed adenocarcinoma of the lung. The incidence of lung cancer in human beings residing in urban and rural communities was compared for the total U.S.A. and for each state and the District of Columbia for the years 1930-34. A much greater incidence occurred in those living in the cities rather than in those living in the country. It is concluded that though it is impossible, off hand, to establish a direct causal relationship between smoke and soot and lung cancer in man, census statistics are suggestive enough to stimulate further studies of the subject.

631. Wiley, F.H., Hueper, W.C. and von Oettingen, W.F.: On the toxic effects of low concentrations of carbon disulfide. J. Ind. Hyg. Toxicol. 18:733-40, 1936.

Ten rats and 20 mice were exposed to 1.09 mg. CS_2/l. air for 8 hr./day, 5 da./wk. for 20 wk. 5 mice and 3 rats died spontaneously during the experiments and the rest were killed at intervals. The degenerative changes in the testicles of the rats and in the liver of the mice, the irritation of the intestinal tract and the regressive changes in the central nervous system were probably caused by prolonged exposure to CS_2, whereas the purulent bronchitis observed in the rats and mice that died spontaneously and in some of the mice that were killed was probably caused by an inflammatory condition that was common among the authors' stock animals at that time. In a 2nd series of experiments, 10 rats and 20 mice were exposed to 0.114 mg./l. for 20 wk. 5 mice and 2 rats died during the experiments and the rest were killed at intervals. The pathological findings in the animals were characterized by degenerative changes in the brain, moderate regressive lesions of the liver and kidneys, inflammatory edema and leucocytic exudations of the mucosa of the intestinal tract and more or less severe purulent bronchitis and pneumonia. It is not certain that the pulmonary symptoms should be attributed to the CS_2. A review of some of the literature on chronic exposure of animals and man, especially in the rubber industry, to CS_2 is included. It is concluded from the authors' experiments and from the review that CS_2 concentrations in work operations should be kept below 0.1 mg./l. and that exposure to higher concentrations (up to 1.0 mg./l) should be cut down by shortening the working hours and by transferring the operators periodically to operations where there are no CS_2 hazards.

632. Campbell, J.A.: The effects of road dust "freed" from tar products upon the incidence of primary lung-tumours of mice. Brit. J. Exptl. Pathol. 18:215-23, 1937.

Seventy-eight mice, male and female, were exposed 6 times/day, 5 da./wk. for a year to road dust from which the tar had been completely extracted by benzene. 77 mice, "control A" group, received no exposure, and 79 mice, "control B" group, were exposed for 1 wk. only to dust containing a small amount of tar. No warts or skin cancer appeared from the tar-free dust, as expected. Mice exposed to the tar-free dust showed a definite increase in primary lung tumors over control A mice and these tumors appeared somewhat earlier among the experimental mice that died than among the controls. Control B mice showed a slight increase in incidence of lung tumors compared with control A mice. At the end of the experiment, lung tumors were found in 10 of the control A mice, 14 of the control B and 26 of the exposed mice. The results of this experiment when compared with those from the tar dust experiment show that tar not only increases the incidence of primary lung tumors, but also accelerates their appearance. On the 500th day using tar-free dust only 15% (4 out of 27 mice) possessed lung tumors; of the mice exposed to tar dust 60% (24 out of 40) revealed such tumors. The dust does not cause any obvious inflammatory reaction, apart from the tumors themselves, in the lung or lymph glands. It is suggested that the presence of lung tumors in the control mice is due in part to the dust breathed from the contents of their boxes or from the general atmosphere. This dust may contain a carcinogenic agent, e.g., tar, or it may "irritate" the lung without obvious inflammatory reaction. As far as the authors know this is the 1st report of metastases from lung tumors in mice in their country. The majority of the lung tumors in the dusted mice were malignant.

633. Schnurer, L.: Effects of inhalation of smoke from common fuels. Am. J. Public Health 27:1010-22, 1937.

Into each of 4 gas-tight exposure chambers were placed 4 rabbits and 8 rats. 17 da. before the end of the experiment 4 mice were added to each chamber. One of the chambers was used as a control and the other 3 vented with the flue gases from the burning of the same weight of anthracite (nut), coke (domestic) and bituminous coal (ca. 35% slack), respectively. The average concentrations of the constituents in the air-gas mixtures were: for anthracite 20.6% O_2, 0.4% CO_2, 1.91 ppm SO_2 and 312 particles dust/cc.; for coke 20.1% O_2, 0.5% CO_2, 9.12 ppm SO_2 and 370 particles dust/cc.; for bituminous coal 20.0% O_2, 0.6% CO_2, 7.51 ppm SO_2 and 4,410 particles dust/cc. and for control 125 particles/cc. and usual atmospheric concentrations of the gases. The maximum and minimum concentrations are also given. The animals were exposed 23 hr./day for 80 da. and fed a balanced diet. The following are the results as summarized by the author. Considering the weight gain of the control animals as 100%, the anthracite rats gained 105%, the coke animals gained 114% and the bituminous group 75%; among rabbits, the anthracite gain was 84%, coke 77% and bituminous coal 9%. The % of hemoglobin and the number of red and white blood cells/mm.^{3} of blood rose consistently in all groups of animals, but this rise was least noticeable in the anthracite rabbits. The most immediate and pronounced blood changes occurred in the direction of leucocytosis, hemoglobin and erythrocytic increase in the animals subjected to bituminous coal. Intermediate deviations were seen in the coke group. Phagocytosis of C pigment in the lungs of the control animals was scarcely seen. It was slight in the animals exposed to anthracite, more obvious in those of the coke chamber and very marked in those subjected to bituminous coal smoke. The greatest number of uncomplicated pneumonias, and the greatest incidence of bronchitis occurred among the animals exposed to the products of combustion of bituminous coal. Not even the faintest suggestion of fibrosis of the lungs was seen in the control animals or those exposed to anthracite or coke. In the lungs of animals exposed to bituminous coal, spindling of C-laden cells--apparently the earliest stage of fibrosis--was noted. It seems likely that soft coal, even when unaccompanied by other dusts, is capable of producing fibrosis if exposure is sufficiently prolonged. It is stated that the results justify further and more complete studies along the same line.

634. Schnurer, L. and Haythorn, S.R.: The effects of coal smoke of known composition on the lungs of animals. Am. J. Pathol. 13:799-810, 1937.

Four rabbits and 8 rats were exposed for 80 da. in closed chambers to bituminous coal smoke containing an average of 125 million particles/ft.^{3} (or 4410 particles cm.^{3}). 0.8% of the particles was free SiO_2. Controls were exposed to clean filtered air. 1 control and 2 exposed rabbits died of bronchopneumonia before the end of exposure. The remaining animals were autopsied, 1 rabbit and 6 rats immediately after exposure, the rest at various other intervals up to 429 da. In those killed immediately, the lung lesions were lesions of nonoccupational anthracosis. Those kept under observation for several months to a year after exposure to smoke developed fibrous reactions about the C deposits with the formation of collagen strands. The resulting lung changes were analogous to those of a milder grade of bituminous pneumoconiosis as seen in soft coal miners. The nature of the stimulus responsible for fibrosis is discussed. It was concluded that, though a small amount of silica was present, C was responsible for both pneumonitis and the fibrosis.

635. Gardner, L.U.: Reaction of the living body to different types of mineral dusts with and without complicating infection. Technical Publication No. 929, American Institute of Mining and Metallurgical Engineers, 1938, 15 pp.

Rabbits were injected by the ear vein with 1-g. dust particles in 20 doses over a period of 2 mo. and guinea pigs received a single 200-mg. injection in the abdominal cavity. At least 4 rabbits and 5 or more guinea pigs were used for each of 4 types of dust tested. The dusts, 3µ or less in diameter, were uncombined SiO_2, silicates, nonsiliceous minerals and mixtures of free SiO_2 with other minerals. The animals were killed at intervals during a 2-yr. period to observe the reaction of the tissues and to determine whether changes of a progressive nature have occurred. Free SiO_2, as normal quartz, vitreous SiO_2, chalcedony, Tripoli (Seneca, Mo.), flint, opal and diatomite caused characteristic fibrosis, i.e., in the form of nodules about the collected masses of SiO_2. Tridymite and crystobalite caused a more rapid fibrosis, while dispersed colloidal SiO_2 gave a very acute inflammation. However, gelled colloidal SiO_2 did not affect the tissue. The rate of reaction to SiO_2 was found to be inversely proportional to the size of the particles. The artificial silicate of Na when injected in the standard dose has an effect like that of dispersed colloidal SiO_2. When injected in minute repeated doses (total 13 mg.) into the lungs of guinea pigs, no fibrosis developed in 4 mo. The other silicates, except the mica, biotite, have generally proved to be as inert as silica gel. Biotite excited definitely proliferative changes in 6 mo. Finely ground asbestos minerals injected into the liver gave no reaction. It is suggested that their irritative effect in the lungs is mechanical in nature. Except for the toxic sulfides and dolomite, the nonsiliceous minerals like the silicates have very little effect upon the tissues. For the period of observation the presence of small and sometimes large amounts of Si in natural and artificial mixtures of free SiO_2 and other substances had little effect. The role of infection is discussed. "Any portion of the body in which tissues are damaged by the scars of previous infections will not dispose of dust particles in the same manner as a normal area; scar tissue tends to retain foreign bodies mechanically and the lymphatic drainage system may be so altered that it functions imperfectly. Mildly irritant mineral particles sometimes exert unusual effects when concentrated in areas already inflamed and active SiO_2 may produce marked and atypical reactions. Thus damage by infection, even though it has healed, may alter the form and the character of silicosis and to a slight degree of the other pneumoconioses." A discussion of pulmonary anatomy, nonspecific pneumoconioses, silicosis and silicosis with infection is also included.

636. Schmidtmann, M.: Über chronische Autoabgasschäden. Untersuchungen am Dieselmotor. (On the chronic pathologic effects of car exhausts. Experiments on diesel engines.) Arch. Gewerbepathol. Gewerbehyg. 8:1-13, 1938.

Rabbits were placed into cages at about 1 m. distance from the exhaust of diesel engine (oil motor), the exhaust gases entering through a screen, for various lengths of time, i.e., for 50 or 25 hr. continuously, alternating with shorter exposures and interrupted by intervals of several hours or longer periods, up to 155 da. At regular intervals before, during and between the exposures, blood tests were made and rabbits were killed and histologically examined. Some died, either spontaneously during exposure, or of supervenient diseases at various times up to 480 da. after the last inhalation. The maximum continuous exposure time was 860 hr.; this rabbit died of cholecystitis 192 da. after the last

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Schmidtmann, M. (continued)
inhalation. The examinations revealed none of the changes in the blood or the hemapoietic organs of the exposed rabbits that are characteristic for the effects of gasoline engine exhaust gases. The prolonged exposure of rabbits to the inhalation of oil engine exhaust gases caused anthracosis due to the soot and to a small amount of unburned oil they contain. This action distinguishes the soot from all other dusts, since the latter, even when inhaled by rabbits for a prolonged period of time, do not reach their lungs. The coal dust is at first deposited in the alveolar cells; soon these form interstitial nodules which are surrounded by infiltrates of lymphocytes. In more advanced states, the dust cells are found in indurations and in the areas surrounding them. The epithelium may eventually have grown into the alveoli, without, however, forming tumors. The experiments demonstrated that the soot from the exhaust gases of diesel engines easily penetrates into the lungs of the exposed rabbits where it is stored and affects the surrounding tissue. These changes were found in the rabbits after the following exposure times: 15 hr., pulmonary emphysema and hyperemia; 50 hr., the lung surface shows a gray color, there is a pulmonary emphysema and some dust cells are found in the alveoli; 100 hr., there are numerous dust cells in the alveoli and on the alveolar walls, irregularly distributed over the lungs: in some isolated groups of alveoli, or, rarely, in the interstitial cells; 150 hr., the condition is not much advanced, the gray color of the lungs is more pronounced, the bronchi are dilated, some bronchi are contracted; 200 hr., the lungs are dilated and pale and contain great quantities of soot, the bronchi are dilated, some are contracted which leads to atelectasis. The coal dust cells have formed interstitial nodules; 250-300 hr., there is a similar picture as after 200 hr., the lymphatic infiltrates have multiplied; over 300 hr., a proliferation of histiocytes around the foci of pigmentation is observed, further a dilatation of the bronchi and trachea, also emphysema and anthracosis of the lungs and hilar lymph nodes; 565 hr., condition exacerbated.

637. Seelig, M.G. and Benignus, E.L.: Lung tumor development in a resistant strain of mice subjected to inhalation of soot. Am. J. Cancer 34:391-8, 1938.

An earlier experiment (Seelig, et al.: Am. J. Cancer 28:96-111, 1936) was repeated under more controlled conditions. 150 6-mo. old mice of the C_{57} Black strain, a strain markedly resistant to lung tumors, were used. 100 were placed in cages in which tar-free lampblack with added 10% pure gas-works tar of known carcinogenic activity was used as bedding. The cages were shaken 2 or 3 times daily to stir up the dust. 50 mice were used as controls. At the end of 10 mo. all but 16 controls and 5 experimental mice had died. These were then autopsied. No lung tumors occurred in the 100 exposed mice, though 2 spontaneous lung tumors (4% incidence) were found in the controls. The impregnation of dust in the lungs of the experimental mice was increasingly more thorough with time, until finally the black granules were seen intracellularly and intra-alveolarly, in the bronchi and in the interstitial tissue. Most of the lungs showed inflammatory processes, usually pneumonic, which were notably more acute and extensive in the lampblack mice than in the controls. Besides this inflammatory reaction, in 20 of the lampblack mice there were proliferations of alveolar and bronchiolar epithelium so markedly hyperplastic as to suggest early neoplasm. Though the general morphology was somewhat suggestive of malignancy, the essential characteristics of carcinoma were lacking,

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Seelig, M.G. et al. (continued)
and therefore, these growths were interpreted as most probably inflammatory in nature. The amount and severity of infection was of a notably lower degree in the control mice, with no extensive epithelial hyperplasia and proliferation. However, in each of 2 controls, there was a very small tumor corresponding to the papillary cystadenoma type. It is concluded that the difference of tumor incidence in this experiment (with 10% tar) and the earlier experiment (with 5% tar) is possibly due to (a) the varying tumor susceptibility in the 2 different strains of mice used and (b) to the irritating effect of soot particles in the 1st experiment as contrasted with the softer, less traumatizing particles of lampblack used in the 2nd experiment.

638. Shtrum, I.Ya.: The combined action of carbon monoxide and hydrogen sulfide. J. Physiol. U.S.S.R. 24:624-9, 1938.
The purpose of these experiments was to determine the extent of the combined action of CO and H_2S. To do this, the doses of CO and H_2S were determined which produced some arbitrarily chosen effect and these were designated as 100% doses. Then the effect of various combinations of <100% doses of each gas was observed. In the 1st series of experiments, the concentrations which produced death in ≧2 out of 4 white mice in 30 min. were the 100% doses. These were found to be 0.56-0.6 volume % for CO, as determined in 26 experiments, and 1.5-1.6 mg./l. for H_2S from 21 experiments. Combinations of 50% CO-50% H_2S and 30% CO-70% H_2S, i.e., those totaling 100%, did not produce a positive effect, i.e., ≧50% mortality. Then, combinations totaling 110, 120, 125 and 130% were tried; those between 120-130% yielded positive effects. This result is called incomplete summation and is accounted for in the following way. Fifty % of the fatal dose of H_2S produces some tissue anoxia, which effects would probably not be visible, and the animal can easily recover. Then the addition of the 50% of the fatal dose of CO would produce an anoxemia, i.e., some diminution in the O_2 transport to tissue which cannot use the full quantity of O_2 anyway, and so the CO would not act fatally as would be the case if, to the 1st 50% of the fatal dose, the remaining 50% of this dose had been added. This theory seems to be borne out by the fact that combinations involving %'s close to 0% and to 100%, e.g., 30% CO and 90% H_2S = 120%, gave positive effects, whereas combinations of %'s further away from 0% and 100%, e.g., 60% CO and 70% H_2S = 130%, gave only doubtful effects. In the 2nd series of experiments, the action of concentrations of CO and H_2S, such as occur in metallurgical industries, were measured. The objective sign chosen this time for 100% doses was the definite prolongation of the reflex time in the rabbits hind quarters after a 2-hr. exposure. The initial length of reflex time was established at 0.10-0.12 sec. After introduction of the gas in the chamber the measurement was carried out every 5 min. for 2 hr. The concentrations producing definite lengthening of reflex time were 0.2 mg./l. for CO and 0.45 mg./l. for H_2S as determined in 24 experiments with 7 rabbits. Combinations of the gases were again tried. Only where the concentration of the gases was near 100% and the other near 0% did lengthening of the reflex time occur; where the concentrations of each of the components were removed from 100% of the effective concentration, no lengthening of reflex time occurred. It is concluded that in exposure of rabbits and white mice to combinations of CO and H_2S in high and low concentrations there occurs neither potentiation or simple summation.

639. Campbell, J.A.: Carcinogenic agents present in the atmosphere and incidence of primary lung tumours in mice. Brit. J. Exptl. Pathol. 20:122-32, 1939.

In each case 75 mice were exposed to a moderate cloud of chimney soot and of exhaust soot for 10 min./hr., 6 hr./day, 5 da./wk. for a yr. 75 mice were also used as controls in each case. Experiments were also carried out in which 23-24 mice were painted twice/wk. with a) 4 tar extracts (24 mice each) from road dusts for 6-7 mo.; b) "tar" from cigarette smoke for 20 mo.; c) benzene extract of cardboard for 12 mo.; d) 2 tar extracts (24 mice each) from exhaust soot for 6-12 mo. and e) tar from chimney soot for 6 mo. The mouse-skin tests showed that road dust tar contains potent carcinogenic agents as does chimney soot, but under ordinary conditions the effect of the latter in its action on the skin seems to be mitigated somewhat by the presence of the C of the soot, while the effect of the former seems to be aided by the presence of inorganic constituents. Of the 87 surviving mice, 16 of the skin cancer cases gave rise to metastases in the lung and primary lung tumors developed in 10 others. Under ordinary circumstances, the tar in cigarette smoke may occasionally produce hyperplasia and cancer of the skin after prolonged application. 7 (35%) of the mice surviving 10 mo. exhibited primary lung carcinoma. Tarry matters from the motor-exhaust soot and from the cardboard tested did not produce cancer when painted on the skin of mice, but 10 (50%) of the surviving mice painted with the former and 5 painted with the latter developed lung tumors.

The results for primary lung tumors from the inhalation experiments, together with those done previously, are summarized. The % of normal control mice, living 10 mo. or longer, having lung tumors ranged from 8-20%; for those inhaling motor exhaust gases, 20 and 18%; chimney soot 26%; road dust for 1 wk. only, 30%; cigarette smoke, 30%; exhaust soot, 33%; road dust less tar, 45%; with tar, 74%; with tar plus CO, 47%. The age of the mice ranged from 664-919 da. It is considered that the inorganic constituents in the road dust (e.g., SiO_2, Fe) enhance or aid the effect of the tar, while, on the other hand, the C of soot tends to mitigate any effects of the tar present in producing tumors of the lungs. Irritation without inflammation appears to play a part in the genesis of these tumors both in control and experimental mice. Although some primary lung tumors in mice are simple adenomata, other tumors reveal characters of typical malignancy with production sometimes of metastases. Further examples of metastases have been obtained.

640. Kraut, H.: Physiologisch-chemische Auswirkung der Auspuffgase. (Physiological-chemical effect of exhaust gases.) Jahrb. brennkrafttechn. Ges. 20:7-16, 1939.

The physiological effect of motor exhaust gases is attributed mainly to the action of CO. The saturation of the blood hemoglobin with CO is given for the following concentrations (CO given in volume%): 0.01 - 12%, 0.02 - 22% and 0.04 - 36%. The saturation times decrease with increasing exertion. On inhalation of 0.03% of CO, an 18% saturation of the Hb is reached: during strenuous exercise, within 25 min., at rest, within 80 min. Description of various types of exposure to CO illustrates that a moderate charge of the Hb with CO, which does not produce acute symptoms, may noticeably reduce the exposed individual's capacity for physical exertion. The degree of dilution of car exhausts was studied in a 3-hr. test drive through a narrow valley in the Harz mountains, in which 10 cars were used. The average CO content of the exhaust gases was (given in volume %) 4.0%, that of the surrounding air within 12 m. distance - 0.01 during driving and 0.026 during idling.

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Kraut, H. (continued)

The question of chronic poisoning due to other constituents of exhaust gases has not yet been answered, but such poisoning is not likely to occur, as is shown in the cases of exhausts from fuel containing MeOH. The physiological action of exhaust gases from diesel motors was studied in animal experiments. a) Dogs, mice, pigs and rabbits were exposed to aerosols of heavy oils. No weights of the animals, exposure times or droplet sizes are given. The pigs and rabbits proved most sensitive. b) The exposure of dogs and rabbits to exhaust gases from diesel motors caused occasional irritations, due to an SO_2 content of 0.4 mg./l. of air. Concentrations of 0.1-0.3 SO_2/l. of air cause severe irritations in the exposed persons, that of 0.05 mg./l. affects the eyes. The author discusses injury to the lungs from the deposition of soot. Samples of soot, collected by means of ionizing electrodes contained an average of 1.0-2.0% of the unburned heavy oil, the average particle size being <1μ. The soot samples from exhausts of diesel fuel containing 0.2% S were found to have an S content of 4.0%.

641. Weedon, F.R., Hartzell, A. and Setterstrom, C.: Effects on animals of prolonged exposure to sulfur dioxide. Contribs. Boyce Thompson Inst. 10:281-324, 1939.

A series of experiments were conducted to test the effects on male guinea pigs and mice (vertebrates) and on grasshoppers and cockroaches (invertebrates) of prolonged exposure to controlled concentrations of SO_2. With the vertebrates, the effects of the age of the animals, pretreatment with SO_2, intermittent exposures of varying lengths of time and exercise on the susceptibility to SO_2 were determined. Animals were kept in the gas until 50% or more of the animals had died or until no progressive symptoms developed after a considerable period of gas treatment, after which they were transferred to a SO_2-free atmosphere. Concentrations of 10.7, 25.3, 33.0, 63.7, 109.0, 151, 296 and 1014 ppm SO_2 were tested. The data on the susceptibility of animals to SO_2, including hr./day in SO_2, average SO_2 concentration (ppm), length of gas treatment (total hr.), number of animals exposed to SO_2, number of animals dead at end of treatment, length of exposure to SO_2 of animals that died in gas (hr.), total number animals dead 2 wk. after treatment, are grouped together for all concentrations and tabulated as: guinea pigs and mice exposed continuously, guinea pigs and mice exposed intermittently, guinea pigs exercised and exposed continuously and the effect of SO_2 pretreatment and age of guinea pigs. Temperature and humidity data for the fumigations are also tabulated. In general, resistance to the gas was greater than had been expected, and signs of distress were less. No significant mortality or signs of distress occurred among healthy animals at concentrations of 33 ppm or below. Neither age of the animals nor pretreatment with SO_2 effected susceptibility to SO_2. Exercise disposed a greater susceptibility to 1000 ppm but had no significant effect at lower concentrations. A longer exposure to the gas was necessary to cause mortality when the SO_2 treatments were given in intermittent doses of 8 hr. and 4 hr./day. At concentrations of 150 ppm and below, mice were more resistant than guinea pigs, but they were more susceptible at concentrations of 300 ppm and 1000 ppm indicating a difference in slope of the dosage-time curves of the 2 species. The susceptibility of both grasshoppers and cockroaches approximated that of the mice. Signs in living exposed vertebrate animals at the higher concentrations included lethargy, rhinitis, lachrymation, coughing, conjunctivitis, moderate dyspnea, distention of the abdomen, weakness and paralysis of the hind quarters. The probable effects of SO_2 on health

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Weedon, F.R. et al. (continued)

are discussed. The authors state that the results of the experiment indicate that concentrations of SO_2 such as prevail in city atmospheres have no direct effect on health for no mortality among healthy mice or guinea pigs resulted from 47 da. of continuous exposure to 25.3 ppm SO_2 and no abnormal symptoms of any sort developed during 30 da. of continuous exposure of guinea pigs to 10.7 ppm. A city dweller in a highly industrialized city, e.g., St. Louis, is subjected to concentrations >2 ppm for <20 da. during a lifetime of 60 yr. However, the possibility that SO_2 has an indirect bearing on health by effecting a predisposition to a disease or infection cannot be evaluated from the data given in this paper.

642. Arloing, F., Berthet, E. and Viallier, J.: Action de l'intoxication chronique par une atmosphère de chlore à faible concentration sur la tuberculose expérimentale du cobaye. (Effect of chronic intoxication with chlorine at low concentrations on experimental tuberculosis in guinea pigs.) Presse méd. 48:361, 1940.

Four groups of guinea pigs, 2 experimental and 2 control, of average weight of 6.0 kg., were treated in the following manner: a) first infected with t.b., then exposed to Cl_2, b) first exposed to Cl_2 and then infected with t.b., c) infected with t.b., d) exposed to Cl_2. The animals of groups a, b and d were kept in air-tight glass cages where they inhaled for 47 da., 5 hr./day=235 hr., Cl_2 at a concentration of 5 mg./l. air, which is stated to be the usual exposure in industry. Virulent human t.b. bacilli, diluted to 1:10,000, were injected in the following manner: (1) subcutaneously, (2) into the paratracheal cervical ganglion, (3) into the conjunctiva, (4) intratracheally. For results see tables. The following conclusions are drawn from the results: the average survival time of group a was shorter than that of group c, that of group b was shorter than those of both groups a and c. Chronic Cl_2 poisoning in guinea pigs accelerated the experimental tuberculous process in the animals, regardless of whether Cl_2 had been administered before or after the infection. Preemployment examination and regular medical supervision of workers exposed to inhalation of Cl_2 on their jobs would rule out those with latent or active tuberculosis and would prevent the development of the tuberculosis in those who are predisposed due to former Cl_2 poisoning or due to their chronic exposure to Cl_2.

Table I

Method of injection of bacillus tuberculosis	Average survival time guinea pigs group c)			Average survival time guinea pigs group a)		
		minimum	maximum		minimum	maximum
	days	days	days	days	days	days
subcutaneously	200	142	275	145	110	175
into ganglion	215	198	232	203	110	264
into conjunctiva	250	220	280	205	160	250
intratracheally	99	84	114	70	48	107

Table II

Method of injection of bacillus tuberculosis	Average survival time guinea pigs group d)	Average survival time guinea pigs group b)		
			minimum	maximum
		days	days	days
subcutaneously	41 exposures of 5 hr. each were without influence on the survival time	123	49	177
into ganglion		139	127	169
into conjunctiva		190	172	208

643. Moser, P.: Über chronische Schwefelwasserstoffatmung an Hunden. (Effect of prolonged inhalation of hydrogen sulfide in dogs.) Arch. Exptl. Pathol. Pharmakol. 196:446-54, 1940.

Two dogs were exposed for 2 wk., 7 hr./day, to inhalation of 0.001%= 0.014 mg. H_2S/l. air. The gas was added to an air flow directed into the inhalation chamber, 8 m.^{3} in size, and kept in even distribution. No signs of poisoning could be detected in the dogs after the termination of exposure. A slight cough and increased thirst were the only results. The same 2 dogs and 2 additional dogs were exposed for 2 mo., 7 hr./day, to the inhalation of H_2S at concentrations varying between 0.009 and 0.01%= 0.13-0.15 mg. H_2S/l. air. The minimum and maximum concentrations measured were 0.006% and 0.015% H_2S, respectively. These symptoms are described as the results of the exposure: during the first days of the experiment, the animals were less lively, frequently yawned and occasionally choked. Following each exposure, they drank abundantly but ate little. This picture was later less pronounced. All dogs developed laryngitis, cough, rhinitis, conjunctivitis and increased lacrimal secretion. During the course of the whole experiment, the symptoms quickly subsided after the dogs were removed from the exposure, so that the animals were completely normal each morning before the new inhalation began. The blood tests showed no changes in the blood that would indicate poisoning. Due to the irritation of the mucosae, there were some slight changes in the number of leucocytes. The weights of the dogs were the same at the beginning and at the end of the experiment, although occasionally some dyspepsia had been noticed. The following conclusions are drawn from the experimental results. The inhalation of H_2S at the given experimental concentrations caused irritations in the respiratory tract of the dogs exposed. Some dogs had occasional gastrointestinal disturbances, which, however, were not severe enough to produce a change in their weights. The picture demonstrated by the experimental animals closely corresponds with the clinical picture usually seen in humans exposed to the inhalation of the gas. The inhaled H_2S is rapidly oxidized in the organism, and there are no accumulations of the gas in the body that could result in chronic poisoning when a certain level is reached. No blood changes are caused; no sulfhemoglobin was found in the blood. It is mentioned that one dog suddenly died a few days after the beginning of the inhalations. Autopsy revealed that it had pulmonary edema, hyperemia of the lungs as well as of all other organs, chronic tracheitis and a soft liver.

Neither an increased sensitivity nor an adaptation to the inhalation of H_2S was demonstrated by the dogs exposed to the inhalation of the gas at the given experimental concentrations.

644. Setterstrom, C.: Effects of sulfur dioxide on plant and animals. Ind. Eng. Chem. 32:473-9, 1940.

In cases where only 0.1-0.2 ppm SO_2 were used on experimental animals, nothing injurious happened because the S deficiencies of nutrient supplies were augmented by the atmospheric SO_2. Factors influencing the effect of SO_2 on plants are: (1) Resistance was greater at 40° F. or below; (2) resistances decreased with increases in relative humidity; (3) ample H_2O supply made them more susceptible and (4) younger plants were more resistant than older ones. The studies of effects on animals of prolonged exposures to SO_2 are reviewed. (Abst. Heimann, H., et al.: U.S. Public Health Service, 1950.)

645. Weedon, F.R., Hartzell, A. and Setterstrom, C.: Toxicity of ammonia, chlorine, hydrogen cyanide, hydrogen sulfide and sulfur dioxide gases. V. Animals. Contribs. Boyce Thompson Inst. 11:365-85, 1940.

Three rats and 4 mice in each experiment were exposed to a continuous flow of NH_3, Cl_2, HCN, H_2S and SO_2 under controlled conditions at concentrations of 16, 63, 250 and 1000 ppm for 16 hr. or until death. Those that survived and the controls were kept under observation about 5 mo. after which autopsies were made on representative individuals. Toxicity curves are presented for each of the organisms at the various concentrations for the various gases; visible signs and symptoms are described; pathological signs in vertebrates on autopsy are summarized. The order of decreasing toxicity of the gases was found to be HCN, H_2S, Cl_2, SO_2 and NH_3. During exposure to Cl_2 the rodents showed little initial excitement but early signs of irritation of eyes and nose and early and increasing signs of pulmonary edema. Except for terminal convulsions, there was comparatively little activity. In HCN after an initial lag period the rodents showed a period of wild excitement and loss of muscular coordination followed by coma ending in a terminal convulsion. At progressively lower concentrations all these periods including the initial lag were progressively longer but still definite including the 63 ppm level. However, at 16 ppm the rodents showed no effect. It is of interest that at 63 ppm the LT_{50} (lethal time to kill 50% of the animals) was much greater for mice than for rats though the rats died at the higher concentrations, indicating a difference in the slope of the dosage-time curves of the 2 species. At high concentrations of H_2S there was violent activity and loss of muscular coordination very similar to that seen with HCN; at progressively lower concentrations there was progressively less activity. In addition in the lower concentrations there was evidence of irritation of eyes and nose and of pulmonary edema increasing with time of exposure. Exposure to NH_3 caused only very slight irritation to eyes and nose. With SO_2 the signs qualitatively resembled those of Cl_2. Study of the organs at death revealed that the rats exposed to Cl_2 showed much edema and slight to moderate hemorrhage of the lungs while the mice showed somewhat less edema and more hemmorhage, the hemorrhage probably causing death in the smaller animal before the edema was fully developed. The heart was more dilated in rats than in mice. The organs of the rodents dying in HCN showed no change of importance except a bright red color of the blood in some animals. Examination of rodents exposed to 1000 ppm H_2S showed only slight to moderate change of heart and lungs while those exposed to 250 ppm showed severe pulmonary edema and hemorrhage and definite dilatation of the heart. The changes in the 1 rodent in NH_3 dying later are those of acute pulmonary edema. In those rodents exposed to SO_2 at 1000 ppm in spite of the difference between the LT_{50} of the mice and that of the rats there was little difference in the appearance of the lungs, which were moderately edematous and showed few hemorrhages. The heart in both species was usually much dilated. As for the other organs venous congestion was not great in any animal. In all, the stomachs were moderately dilated but without ulcers.

646.✓ Dudley, H.C. and Miller, J.W.: Effects of subacute exposure to hydrogen selenide. J. Ind. Hyg. Toxicol. 23:470-7, 1941.

Groups of 16 guinea pigs each, ranging in weight from 451 to 701 g., inhaled in single exposures extending over 2, 4 and 8 hr., H_2Se in varying concentrations. Tne observed symptoms, mortality rates and histopathological findings are discussed. The concentration ranges, given in mg./l. (under the supposition 1 mg. H_2Se/l. = 302 ppm = 0.027 volume %),

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Dudley, H.C. et al. (continued)
were as follows: 2 hr., 0.006-0.036; 4 hr., 0.006-0.045; 8 hr., 0.001-0.042. The temperatures were recorded as 21-25° C., the humidity as 42-86%, without having any influence, apparently, on the action of H_2Se. Some trial tests involving guinea pigs ranging in weight from 189 to 283 g. demonstrated that the size of the animals did not affect the death rates. The animals exposed to <0.021 mg. H_2Se/l. of air for 2, 4 and 8 hr. showed slight, red-colored nasal discharge and immediate recovery after the termination of exposure, but 24 hr. later, dyspnea was observed. Concentrations of >0.021 mg./l. caused irritations of nose and eyes and dyspnea immediately after exposure, as well as weight loss and debility. 2 animals died during the 8-hr. exposure. In guinea pigs dying 48 hr. later, respiratory and circulatory disturbances and some hepatic changes predominated, while in those dying 5 or more days later, subacute bronchial pneumonia persisted for extended periods of time. The death rates following exposure, in relation to concentrations of H_2Se (given in mg./l. of air) and duration of exposure, may be summarized as follows:

2 hr. at 0.006, 12.5% within 30 da.; at 0.036, 93.7% within 30 da., 4 hr. at 0.006, 18.8% within 30 da.; at 0.045, all guinea pigs within 8 da.; 8 hr. at 0.001, 50.0% within 30 da.; at 0.042, all guinea pigs within 10 da.

The following concentrations resulted in death of 50% of the exposed animals within 30 da. after these inhalation times:

1 hour at 0.013 mg./l; 4 hr. at 0.009 mg./l; and 8 hr. at 0.001-0.004 mg. H_2Se/l. of air. The histopathological findings indicated that the early fatty metamorphosis of the liver subsides when spleen changes progress to a moderate degree, 17 da. after the exposure being the turning point.

In man, 0.005 mg. H_2Se/l. of air produces irritation of eyes and nose and is intolerable; 0.001 mg./l. causes olfactory fatigue and is considered dangerous, expecially at exposures exceeding 4 hr. Any concentrations detectable by odor are potentially injurious.

647 La Towsky, L.W., MacQuiddy, E.L. and Tollman, J.P.: Toxicology of oxides of nitrogen: I. Toxic concentrations. J. Ind. Hyg. Toxicol. 23:129-33, 1941.

112 animals, including cats, rabbits, guinea pigs, mice and rats, were exposed to concentrations of NO_2 ranging from 30-1000 ppm (at 25° C. and 760 mm.). 84 died from the effects of exposure of which 88% died from lung edema, 6% of asphyxia and 6% of pneumonitis. 30 ppm NO_2, for 3 hr. exposure, produces no immediate or delayed harmful effects on guinea pigs. 55 ppm NO_2 for 2 or 3 hr. may or may not produce immediate or delayed harmful effects on rats and mice, but no effects on rabbits, cats or guinea pigs. It is rare that any species or weight of animal can stand concentrations of NO_2 of 100 ppm and above. Death occurs within a period of from 21 hr. to only 10 min. exposure, depending upon the concentration above this minimum. Of all the animals used the cat appears to be the most susceptible to poisoning by oxides of N. When they are placed in the gassing chamber, they thrash about excitedly. Such activity requires a greater respiratory exchange and thus increases the amount of toxic gas inhaled in any given time. Methemoglobin is frequently seen in the blood of animals during exposure and immediately after exposure. However it disappears rapidly from the blood when exposure ceases. It may be completely absent in from 1-2 hr. after removal of the animal from exposure. A review of toxic concentrations of oxides of N, together with condition and time of exposure, gathered from several sources is included.

648. Liese, W.: Zur Frage der Giftigkeit von Trichloracetonitril ("Tritox") und Schwefeldioxyd. (The toxicity of trichloroacetonitrile and sulfur dioxide.) Z. Hyg. Zool. Schädlingsbekämpf. 33:1-4, 1941.

In comparative inhalation experiments, mice were exposed to various concentrations of both SO_2 and trichloroacetonitrile (Tritox), 2 insecticides used for indoor fumigation. In 11 experiments, groups of 5 mice each were exposed for 15-60 min. to a mixed gas stream containing one of the 2 gases in concentrations that were continually controlled and determined by the following determination methods: for SO_2, with sodium thiosulfate; for Tritox, with Kjeldahl's method of N determination. Ranges (r) and medians (m) of the experimental gas concentrations, given as g./m.^{3} air, are: for SO_2, r:0.76-7.5, m: 2.14; for Tritox, r: 2.9-27.0, m: 8.4. The reason for increasing the Tritox concentrations during the course of the experiments will be explained by the results. The action of the 2 gases on the organisms of the mice was demonstrated by the following symptoms: SO_2 caused severe irritation of the mucosae, restlessness and irregular respiration. Death of the mice exposed to SO_2 occurred during or shortly after the experiments. The animals inhaling the Tritox gas mixture at first were numb and rather motionless. Later they performed somewhat staggering movements or convulsive jumps and showed accelerated respiration. Some of them recovered fast after the termination of the experiments, several, however, died the following day after first demonstrating signs of considerable improvement. In order to confirm the experimental findings as to the MTD of SO_2 for mice, 3 groups of 10 mice each were kept for 40-200 min. in a gas chamber containing 10 m.^{3} of gas mixtures with SO_2 concentrations of 0.96, 2.3 and 2.9 g./m.^{3}.

The results of both series of experiments as to the reaction of the organisms of mice to the various concentrations of both gases may be summarized as follows (concentrations given as g./m.^{3}): Tritox was tolerated by the majority of mice for up to 40 min. at a concentration of 2.9, while at 8.0, no animal survived the same length of time. 1.0 SO_2 or less was tolerated by all mice for 200 min., 2.0 by all for up to 15 min., 2.14 by most mice for 15-40 min., while the concentration of 2.76 was lethal for all mice. Death at this concentration occurred at 15-40 min. Although it was demonstrated during these experiments that mice tolerate higher concentrations of Tritox than of SO_2, it was also shown that the inhalation of Tritox may have serious aftereffects and can lead to death as late as on the following day after striking temporary improvement. Thus, it is not justified to consider the latter gas less toxic than SO_2.

649. MacQuiddy, E.L., La Towsky, L.W., Tollman, J.P. and Finlayson, A.I.: Toxicology of oxides of nitrogen. II. Physiological effects and symptomatology. J. Ind. Hyg. Toxicol. 23:134-40, 1941.

This is a description of the physiological effects and symptomatology of NO_2 poisoning of animals as carried out in a previous experiment. (See La Towsky, L.W., et al.: Ibid. 23:129-33, 1941.) Animals dying from acute poisoning by the oxides of N may die from lung edema, asphyxia or pneumonitis. In death from lung edema there is a marked concentration of blood due to loss of the fluid portion of the blood into the air spaces of the lungs. Methemoglobin, in the blood of animals dying from acute poisoning with oxides of N is quite a common finding. Animals dying from acute poisoning from the oxides of N show a marked drop in blood pressure and a stimulation followed by a failure of respiration. In acute death from inhalation of oxides of N the respiration and heart fail at approximately the same time. Calculated amounts of NO_2, HNO_2 and HNO_3 formed in the lungs of a human breathing various concentrations of the oxides of N are given. Symptoms of acute poisoning by oxides of N are discussed in the light of experimental physiologic findings on laboratory animals and reported in the literature.

650. Campbell, J.A.: Lung tumours in mice; incidence as affected by inhalation of certain carcinogenic agents and some dusts. Brit. Med. J. 1:217-21, 1942.

In each experiment 150 mice, 75 for the dusted group and 75 controls, were exposed in closed chambers to a moderate cloud of dust once/hr., 6 times/day, 5 da./wk. for 1 yr. The mice, equally divided as to sex, were 3 mo. old at start and allowed to complete their allotted span of life. Histological sections were made of all lungs, tracheobronchial glands and any organ showing pathological change. Dusts used were precipitated SiO_2 + methylcholanthrene, steel grindings, $Al_2O_3 + SiO_2 + Fe_2O_3$, Czechoslovak dust, $Al_2O_3 + SiO_2 + Fe_2O_3 + CaCO_3$, and tarred road dust. All the dusts increased the incidence of primary lung tumor in mice. The tarred road dust was obtained ca. 5 yr. after tarring; it still contained ca. 2% tar, but the carcinogenic agent, although still there, was not so active as in the experiment with freshly tarred road dust (Campbell, J.A.: Brit. J. Exptl. Pathol. 15: 287-94, 1934). No skin cancer was produced by dusting alone. About a 9-fold increase in lung tumors was produced, there being 8 (13.1%) of the 61 dusted mice and 1 (1.4%) of the 69 control mice with tumors. The deposit of tarred dust in the lungs was moderate, in some of the lymph glands - very heavy. However, only hyperplasia occurred in these.

651. Cralley, L.V.: The effect of irritant gases upon the rate of ciliary activity. J. Ind. Hyg. Toxicol. 24:193-8, 1942.

A method for the quantitative study of the effect of irritant gases on ciliary activity (excised tissue) is described. In the use of this method the temperature and humidity are controlled and the gas to be studied is passed over the tissue at a rate comparable to that of breathing by the experimental animal, viz., the rabbit. A comparison of the effect of SO_2 on freshly excised rabbit tissue with the effect of this gas on intact tissue in the human subject showed that the ratio of the response was the same. The intensity of the response was greater with excised tissue. The excised tissue was discarded when the elapsed time after death of the rabbit was greater than 2.5 hr., for the ciliated epithelium became increasingly susceptible to the effect of an irritant gas (SO_2) with the lapse of time after its removal from the rabbit. Excised tissue tested 7.5 hr. after its removal from the animal was 4 times as sensitive as tissue studied within 0.5 hr. after its removal, as shown on the basis of complete cessation of ciliary activity. The critical zone beyond which complete cessation of ciliary activity (excised tissue) takes place is relatively narrow as to concentration and time. After 5 min. exposure this zone in concentration of the gases studied was approximately 30 ppm Cl_2, SO_2 and HCHO; 60 ppm HCl and NO_2; 400 ppm NH_3; 500 ppm H_2S. The pH resulting from the dissolution of the active gases, e.g., NO_2 and Cl_2, in the aqueous layer covering the cilia is undoubtedly a factor in stopping ciliary activity. The immediate irritation of the throat on exposure to certain irritant gases (as reported in literature) offers a comparative index as to the depressing effect of these gases on freshly excised ciliated epithelium. The rate of removal of a drop of amaranth (a red dye) placed in the active ciliary region of the inferior meatus of a human subject was studied. The time interval between the introduction of the dye and its first appearance in the expelled mucus served as an index of the rate of removal. The rates when the subject breathed normal air and when he breathed a known concentration SO_2 for a given length of time before introduction of the dye were compared. It was found that exposure to 10-15 ppm SO_2 for 1 hr. produced only a small decrease in the rate of removal of the mucus, but at 25 ppm, the depression of ciliary activity was approximately 50% and exposures of 30 min. to 50 ppm produced a 65-70% depression of activity. It is suggested that exposure to small amounts of irritant gases for long periods of time may lead to a chronic irritation of the mucosa which would accordingly affect ciliary activity.

652. Dickens, F. and Weil-Malherbe, H.: Investigation into the possible carcinogenic activity of wood smoke. Cancer Research 2:680-4, 1942.

Four groups of 20 mice were painted twice/wk. for a period up to 24 mo. with 4 fractions of wood smoke condensates, prepared under conditions closely resembling those employed in the food-smoking industry. These fractions consisted of (1) material extracted by ether from pyroligneous acid, (2) tar separated out from pyroligneous acid, (3) products extracted from smoke scrubbers by methylene dichloride and (4) products extracted by acetone subsequent to methylene dichloride extraction. At the site of application only 1 papilloma was observed, which appeared after 22 mo. and spontaneously regressed a mo. later. On the other hand, single and multiple pulmonary adenomas were found in 8 of 17 mice painted for 18 mo. or more with the tar fraction which had settled out from the "pyroligneous liquor." In another series of experiments rats were fed smoked fish or meat 3 times/wk. for periods of to 20 mo. No neoplasms developed. (From authors' summary.)

✓ 653. Leiter, J. and Shear, M.J.: Production of tumors in mice with tars from city air dusts. J. Natl. Cancer Inst. 3:167-74, 1942.

A new dust collector was designed, with a capacity of 275 ft.^{3} air/min., in which a single sheet of paper 17' X 2' was the filter. The paper had a low resistance to air flow and a high efficiency for retention of very small particles. A unit of this collector was installed in each of the following cities: Chicago, East St. Louis, Cincinnati, Youngstown and South Charleston, W.Va. In addition, a cloth-filter-bag apparatus and an electric precipitron were employed in Pittsburgh, and another electric precipitron in East St. Louis. Samples of dust from the intake and exhaust air of both the New York and New Jersey ends of the Holland Tunnel were obtained from the labyrinths of the ventilating system of the tunnel. Black tar was extracted with benzene from the specimens of black dust obtained from the collectors. The tars were dispersed in tricaprylin and injected subcutaneously in the right axilla in 400 male C3H mice; 20-32 mice were used for each specimen. A single injection of about 50 mg. of tar, dispersed in 0.25 cc. tricaprylin, was given. The weights of the dust collected (g.) and of the tar extracted (g.), and the number of mice injected for each source of dust are tabulated. The tar injected/mouse (mg.), the dust equivalent (mg.) and the number of mice with a tumor (after 1 yr.) for each source of dust are also tabulated. The first sarcoma appeared at the injection site after 5 mo. at which time there were 372 survivors. By the end of 16 mo. tumors had been obtained in 30 mice (26 had sarcomas, 3-carcinomas, 1-papilloma), which represented an incidence of 8% of the effective total. The rate of tumor production and survival data at 6, 9, 12 and 16 mo. after injection for each source of dust is given. These results confirm and extend those obtained in the preceding study (Leiter, J., Shimkin, M.B. and Shear, M.J.: Ibid. 3:155-65, 1942.)

✓ 654. Leiter, J., Shimkin, M.B. and Shear, M.J.: Production of subcutaneous sarcomas in mice with tars extracted from atmospheric dusts. J. Natl. Cancer Inst. 3:155-65, 1942.

Dusts were obtained from Chelsea, Mass., Pittsburgh, Penn., the intake and exhaust air in the Holland Tunnel (New York City-Jersey City) and Cambridge, Mass. 6 specimens of 20 mg., unextracted dust suspended in saline solution were injected subcutaneously in the right axilla into C3H male mice. 20 mice were used/specimen. The suspensions were also diluted 1:8 and 0.25cc, or 2.5 mg. dust injected in the lateral tail vein in 20-30 strain A mice/specimen. Tars extracted with benzene and dispersed in tricaprylin or in lard filtrate were injected in the right axilla in

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Leiter, J. et al (continued)
amounts of 21-71 mg. 20 C3H male mice, 10 A females and 10 A males were used for each tar specimen. 20 C3H male control mice were injected with 0.25 cc. tricaprylin alone. 30 untreated strain A mice were observed for spontaneous pulmonary tumors. Subcutaneous injection of the unextracted dust into the C3H mice, or of the 0.25 cc. tricaprylin alone did not produce sarcomas at the site of injection in 12 mo. A single subcutaneous injection of ca. 50 mg. of extracted tar produced sarcomas at the site of injection in 18 of an effective total of 291 mice (strain C3H males and strain A mice of both sexes) in 12 mo. The tumors were all pleomorphic, spindle-cell sarcomas, indistinguishable from the tumors elicited with polycyclic carcinogens at the site of subcutaneous injection. Pulmonary tumors and hepatomas were found in both strains of mice treated with the unextracted and extracted dusts and the results are tabulated. However, the incidence compared with that of the controls was not significant.

655. McDonald, S., Jr. and Woodhouse, D.L.: On the nature of mouse lung adenomata, with special reference to the effects of atmospheric dust on the incidence of these tumours. J. Pathol. Bacteriol. 54:1-12, 1942.
A study of pulmonary adenoma occurring in various experimental groups of mice is described. The effect atmospheric dust on the incidence of such adenoma is next described. 100 albino mice were exposed for 47 wk. to the inhalation of atmospheric dust, in which benzpyrene was demonstrated by spectrographic analysis. 48 mice were painted with dust extract twice weekly for 12 mo. The Tyzzer adenoma incidence was 22.8% in the dust inhalation group and 25% in the dust extract painting group as compared with a 14.3 and 15.8% incidence in the controls (150).

656. Machle, W., Kitzmiller, K.V., Scott, E.W. and Treon, J.F.: The effect of the inhalation of hydrogen chloride. J. Ind. Hyg. Toxicol. 24:222-5, 1942.
In each of the 37 experiments, 3 rabbits and 3 guinea pigs were exposed to various concentrations of HCl ranging from 0.05-20.5 mg./l. for time intervals ranging from 5-7200 min. 1 monkey was also used in the 7200 min. experiment. 7 rabbits, 6 guinea pigs and 1 monkey were used as controls. 100% mortality occurred after 30 min. exposure to 6.5 mg./l. and after 2-6 hr. exposure to 1 mg./l. No deaths resulted at 5.5 mg. for 5 min. nor at 0.1 mg. for 1800 min. The animals exposed to 0.05 mg./l. (ca. 30 ppm), 6 hr./day, 5 da./wk. for 4 wk., showed no immediate toxic effects and no pathological changes could be attributed to the exposure. This is considered the upper limit of safety if daily exposures are not continued for longer than a month. The guinea pigs were more severely affected than the other animals by the irritant effects of the gas. The rabbits, however, were more susceptible to the later effects of pulmonary and nasal infections. All concentrations were to some extent irritating to the eyes and mucous membranes; acute distress occurred at higher concentrations. Most of the deaths were due to respiratory effects, though some animals of both species died from liver damage. The experiments showed that HCl has nearly the same immediate toxic action as H_2F_2, but produces less serious permanent effects. The histopathological changes that occurred in the respiratory tract, liver, kidneys and heart are discussed.

657. Weedon, F.R.: Experimental acute gastric ulcer produced in animals by exposure to sulfur dioxide gas. N.Y. State J. Med. 42:620-3, 1942.
The occurrence and nature of gastric ulcers in guinea pigs and mice exposed to controlled concentrations of SO_2 have been described. Concentrations of approximately 10, 25, 35, 65, 100, 150, 300 and 1,000ppm were tested. No effects on the stomach were observed below 65 ppm. At 65 ppm

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Weedon, F.R. (continued)
1/3 of the animals showed acute distention of the stomach on the 9th day, and at 100 ppm half the animals showed distention about the 4th day, while 2 perforations of the stomach occurred. At 200 ppm most animals showed distention and multiple hemorrhagic ulcers on the 3rd day. Perforations were frequent. At 1,000 ppm the ulcers were less frequent and of smaller size, but the life span was shorter. The gross and microscopic appearance of the lesions has been described.

658. Klimmer, O.R.: Beitrag zur Kenntnis der Vergiftungen durch Verbrennungsgase. (Poisoning due to gases of combustion.) Arch. exptl. Pathol. Pharmakol. 201:69-98, 1943.

Experiments have been carried out to examine the effects of exposure to gas mixtures in various combinations. In 14 series (76 exposures), 185 guinea pigs, averaging in weight 430 g., inhaled, for 30 min./test, flowing gas mixtures containing CO, CO_2 and O_2. Before and after each exposure, blood samples were taken for photometric determination by the Ranke and Seydel method. During the tests, the experimental animals were under constant observation. The results may be summarized as follows (% = volume %): (1) 30-min. inhalation of air with normal O_2 and CO_2 contents and 0.1% CO produced a COHb content of 39.5%; at 0.2% CO, the COHb content was 42.5%; at 0.4% CO, it was 52.4%. (2) The addition of 2, 4 and 8% CO_2 to the air, without considerable reduction of the O_2 concentrations and at a steady CO level, led to an increase in respiratory rate and in COHb values but significantly reduced the narcotic effect of the inhaled gas mixture. (3) Maintaining the same CO content but reducing the O_2 content to 10%, i.e., to half of the normal concentration, caused symptoms of severe poisoning and a rise in the COHb values obtained from the exposed animals. (4) At the same concentrations of CO and O_2 as described for(3), the addition of 4% or 8% CO_2 decreased the narcotic effect but produced a rise in COHb. (5) At 2.4% CO, a reduction of the O_2 concentration to 10% without addition of CO_2 led to death within a shorter time than did the addition of 4, 8 or 9% of CO_2 to air with a normal O_2 content. (6) In air with a normal O_2 concentration the toxic action of CO by far exceeded that of 2-8% CO_2. (7) The estimation of the toxicity coefficient according to Deckert proved unsatisfactory in determining the toxic action of the various gas mixtures. (8) The results of the experiments described here demonstrate that in the action of combustion gases, a high CO content and a reduction in O_2 concentration are a far greater hazard than is the presence of CO_2.

659. Jötten, K.W.: Das Tierexperiment im Dienste der Aufklärung und Verhütung von Lungenschädigungen durch Gewerbestaub. (The animal experiment for the purpose of clarifying and preventing lung injuries due to industrial dusts.) Arch. Hyg. u. Bakteriol. 131:222-60, 1944.

Groups of 30 rabbits were exposed to dust concentrations usually prevailing in the industries under investigation, 80-100 mg./m.^{3}, for 6 hr./day for periods of from several mo. to 4 yr., when their lungs were histologically examined. In additional experiments, animals were inoculated with tubercle bacilli or with pneumococci (mice, as well as rabbits); the dust exposure in these tests was limited to 1 hr./day. A detailed description of the quantitative and qualitative analyses of the dusts is given. In 5 series of experiments, the influence of dust inhalations on the development of t.b. indicated the following: Steel grindings, quartz, clay slate and porcelain were most active; fire clay and quartz grog were considerably

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Jötten, K.W. (continued)
less active; carbon, soot, limestone, Thomas slag, cement, tobacco, textile dust and finally the husks of rye, wheat and oats were the least active. $Ca(OH)_2$ and white lead, both highly soluble in the lung fluid, were practically inert. In the case of grog and SiO_2-grog (SiO_2 content 54 and 60%, respectively), the high Al_2O_3 content (28 and 23%, respectively) prevented the usually severe action of SiO_2, demonstrating the modifying influence of some mixed dusts. The following problems were investigated by plant visits and experimentation: pneumonia due to Mn (by inhalation tests with pyrolusite: 85% MnO_2 and Thomas slag: 8.0% Mn); fibrosis of the lung caused by fine, metallic Al dust; cirrhosis of the lung following the inhalation of sillimanite dust ($Al_2O_3 \cdot SiO_2$); and silicosis and silicotuberculosis due to free, crystalline SiO_2 in various concentrations. Various control measures, including technical improvements and applications of control dusts, are discussed. The following conclusions are drawn from the results: 1) Depending on their SiO_2 content, the silicic dusts aggravate pulmonary tuberculous processes and also may cause silicosis and silicotuberculosis. An admixture may reduce or prevent the action of these dusts. 2) Dusts poor in, or free from SiO_2 cause more moderate lung changes. 3) Inhalation of dusts containing Mn may cause pneumonia; that of fine, metallic Al dust, "sclerosis" of the pulmonary connective tissue; that of sillimanite, cirrhosis of the lung, which may be aggravated by a supervenient chronic infection. Individual predisposition and the influence of the social environment are mentioned as further modifying factors.

660. Dernehl, C.U., Nau, C.A. and Sweets, H.H.: Animal studies on the toxicity of inhaled antimony trioxide. J. Ind. Hyg. Toxicol. 27:256-62, 1945.

The results of experiments on 24 guinea pigs inhaling Sb_2O_3 in amounts varying from 13-424 mg. were as follows: (1) Extensive pneumonitis in all animals; (2) fatty degeneration of the liver in 11 out of 15 animals having "exposures" of 77 mg. and above; (3) hypertrophy of the lymphoid follicles of the spleen associated with a decrease in the number of polymorphonuclear leucocytes; (4) a decrease in the number of polymorphonuclear leucocytes (from an average 29% in the controls to 14% in the treated) and eosinophiles (from 3.5%-1.5%) in the circulating blood with a relative increase in the number of lymphocytes (from 64%-78%); (5) a decrease in the total white blood cell count from 10,020-8,650; (6) no pathologic changes demonstrable in the heart or kidneys; (7) normal electrocardiograms in 3 exposed guinea pigs; (8) death of 4 out of 24 animals--mortality rate of 16%; (9) death from pneumonia occurring much more frequently in treated animals than in untreated animals. Electrocardiograms taken on 6 exposed employees in a smelter showed 5 out of the 6 to be normal. The greater toxicity of inhaled dust as compared to ingested dust is discussed.

661. Tebbens, B.D., Schulz, R.Z. and Drinker, P.: The potency of silica particles of different size. J. Ind. Hyg. Toxicol. 27:199-200, 1945.

Ground flint (99.3% pure) was sized into 4 fractions averaging 3.3, 1.7, 1.0 and 0.6 μ. For each size group, 9 rabbits were each injected in the ear vein with 400 mg. dust/saline suspension in 2 equal doses at 3-mo. intervals. 1 animal from each series was sacrificed at about 3-mo. intervals. The livers were examined. The histological developments in the earlier period were identical. The dust was taken up by Kupffer's cells. Those who received SiO_2 particles 0.6-1.0μ in diameter had a gradual increase in the amount of scarring. At the end of 18 mo., the original livers were almost wholly replaced by gristly white, fibrous tissue on whose surface there had occurred a regeneration of liver tissue forming

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Tebbens, B.D. et al (continued)
varying sized nodules. Those animals which had received particles 1.7μ in diameter had only a moderate amount of scarring of the liver, and those receiving 3.3μ SiO_2 dust, while showing slight enlargement of the liver, manifested only a very slight degree of pitting. Photographs of each type liver and of 1 normal one are given. Dust particles were also found in other organs: those ≤1.0μ in the liver, lungs, spleen and bone marrow; those of 1.7μ, in the liver, lungs and partly in the spleen and those of 3.3μ, in the liver and lungs.

662. Yagoda, H. and Donahue, D.D.: Fluorescent mineral dusts as tracers for the localization of particles in tissue. J. Ind. Hyg. Toxicol.27:193-8, 1945.

Dust particles in exposed lung tissue do not have characteristics distinct enough to be positively identified by the usual microscopic methods. Specimens that are fluorescent under UV light of many of the toxic mineral dusts exist, providing a means of tracing in the lung the deposition of fine particles down to ca. 0.5 μ in diameter.

The heterogeneous dust particles of willemite ($2ZnO \cdot SiO_2$-green fluorescence), powdered to pass 100-mesh screen, were insufflated into the lungs of a rabbit, autopsied 18 hr. later. Macroexamination of the trachea and lungs under UV light showed numerous fluorescent particles in the bronchi and alveoli. Staining operations with eosin and methylene blue did not disturb the dust; nor did ashing slowly to 400°C. (muffle furnace) destroy the fluorescence, but rather minute particles were rendered visible in the resulting ash pattern.

A suspension of finely ground hyalite ($SiO_2 \cdot nH_2O$-pale green fluorescence) in normal saline was injected subcutaneously in a rabbit that was sacrificed 30 da. later. Paraffin sections of the developed nodules examined under UV light contained fluorescent foreign dust bodies, showing that the fluorescence was not altered by prolonged action of the tissue fluids.

Thin sections of tissue blocks of animals repeatedly exposed for several months to scheelite dust ($CaWO_4$-bluish fluorescence) were microincinerated to a white ash. Under UV light, they showed the particles located chiefly in dense deposits within thickened interalveolar septa.

By this technic the mineral itself may be used as the source of dust, in which case the results can be directly correlated, or a suitable proportion of a highly fluorescent inorganic compound having similar density, solubility and particle size distribution may be incorporated in the dust, in which case, a proportionate amount of the dust is assumed to accompany the fluorescent particle.

A partial list of fluorescing minerals serviceable as tracers, giving compound, sp. gr., UV radiation, fluorescent color, etc. is included, and directions for the preparation of the tissue for microscopy are described in detail as to fixing, sectioning, microincineration and illumination.

663. Sulman, E. and Sulman, F.: The carcinogenicity of wood soot from the chimney of a smoked sausage factory. Cancer Research 6:366-7, 1946.

Consumption of smoked sausage for 2 yr. did not cause tumors in 20 adult rats. However, the wood smoke used for its preparation contained substances that were carcinogenic on subcutaneous administration in rats and on cutaneous application in mice. Of 18 female rats implanted subcutaneously with fragments of the soot from the factory chimney, 3 developed sarcoma, and of all 10 female mice rubbed on the back of the neck with an alcohol extract of the soot daily for 2 yr., 1 developed carcinoma and 2 sarcoma. No tumors developed in 18 male rats inoculated intrascrotally with soot fragments. (CA 41:200, 1947.)

664. Chernov, V.M. and Liberman, S.S.: (Problem of combined action of carbon monoxide and benzene vapor.) Farmakol. i. toksikol. 10:22 1947.
Experiments were performed with mice to determine the combined toxic action of CO and benzene, such as might develop in those working in motor transport. The concentration, period of exposure and temperature of air in the vapor chambers were noted. It was found that neither CO alone nor benzene alone caused a very marked mortality at certain temperatures. But when animals were exposed to the 2 together the cumulative toxic effect was notable. A rise in temperature considerably increased the toxic action of benzene. The practical importance of these observations is great in view of the many cases of poisoning among those exposed to the 2 substances. (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

665. Hatch, T.F. and Kindsvatter, V.H.: Lung retention of quartz dust smaller than one-half micron. J. Ind. Hyg. Toxicol. 29:342-6, 1947.
Guinea pigs (number unstated) were exposed daily for periods up to 4.5 mo. to quartz dust, $<0.5\mu$ in diameter, that had been atomized from a H_2O suspension. The maximum amount of dust deposited was estimated to be ≤ 35 mg./animal. The animals were sacrificed 4, 9, 11 and 20 wk. after exposure and the lungs examined. Bronchial lymph glands were enlarged in every case, after 20 wk. exposure to >3 times the diameter of the normal gland. After ashing and acid treatment all lung and lymph node sections showed innumerable mineral particles rather evenly distributed. The progressive pathological changes observed in the animals with increasing exposure were summarized. In animals with maximum exposure the spleen was also involved.

666. Dautrebande, L., Highman, B. and Alford, W.C.: Studies on aerosols: I. Reduction of dust deposition in lungs of rabbits by aqueous aerosols. J. Ind. Hyg. Toxicol. 30:103-7, 1948.
It was thought that aerosols would coat fine particles of dust and thereby make them larger and less likely to be deposited in the lung.
10 albino rabbits were exposed for 4.5 - 5 hr. to a dusty atmosphere (0.01-0.04 mg./l. air in a continuous flow of 60 l. air/min.) Simultaneously, 10 similar rabbits were exposed to a similar atmosphere mixed with aerosol. The dust consisted of particles of willemite, a Zn silicate, averaging 0.90μ. The aerosol was dispersed from a 0.1% aq. solution of a wetting agent (Aerosol O.T.) by a M2 aerosol generator at 45 cc. liq./hr. Each mm.^{3} of the aerosol contained more than 500,000 liq. particles $< 1\mu$ and averaging 0.5μ. The 1st set of rabbits on exposure showed irregularity of respiration and 6 of the 10 showed marked cyanosis. The 2nd set on exposure to the dust and aerosol showed no cyanosis nor any serious irregularity of respiration. 1 rabbit of each set was killed 1, 7 and 14 da., and the other 7 immediately after the end of the exposure. After tracheal ligation to prevent collapse, the lungs were removed and fixed for 48 hr. in formalin. Sections from each lobe were mounted in the usual manner. 1 of several serial paraffin sections was ashed at 450°C. for 4 hr.; the others stained (azure eosinate). These were compared.
In the 1st set killed immediately after exposure, slight to moderately severe bronchitis, patchy atelectasis, emphysema and early interstitial pneumonitis were observed. The corresponding 2nd set showed similar but less marked changes. The rabbits in both sets killed 1, 7 and 14 da. after exposure showed slight or no significant pulmonary changes. In rabbits killed immediately after exposure to dust without aerosol, willemite was irregularly distributed throughout the lung parenchyma, but was usually relatively more abundant near the pleura and hilus than in the central portion of the lobes. Small aggregates and particles were scattered, in

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diminishing order of mean size and number, along the inner surface of the bronchi, bronchioles, alveolar ducts and alveoli. With those exposed to dust with aerosol, the distribution was similar but the amount and mean size were smaller. In the rabbits killed 1 day after exposure, small amounts of willemite were observed chiefly in bronchioles, alveolar ducts and alveoli, lesser amounts being observed in those exposed to dust with aerosol. Few particles were seen in those killed 1 and 2 wk. afterwards. In current experiments in which larger amounts of dust were used, considerable willemite was found 1 wk. after exposure, chiefly in the alveolar ducts and alveoli, but was less abundant when aerosol was used.

Therefore, coating the particles with aerosols lessens their irritating and harmful effects, and by coating and agglutination, their penetrating power.

667. Sprague, G.F., Pettengill, A.G. and Stokinger, H.E.: Initial studies of the inhalation toxicity of beryllium sulfate. Federation Proc. 7:257, 1948.

Data from 56 animals representing 6 species were collected to supply information on the toxic effects caused by the inhalation of $BeSO_4 \cdot 4\ H_2O$ at a concentration approximating 90 mg. salt/m.^{3}. The animals were exposed 6 hr./day for a 2-wk. period in a small inhalation exposure chamber. Mortality, for all species, was 43% of the exposed animals or 20 of 20 mice, 2 of 10 rats and 2 of 7 hamsters. No deaths occurred among the 2 dogs, 3 rabbits and 14 guinea pigs. Weight response data showed that all species save the guinea pig were adversely affected by the exposure. The rat and hamster showed greatest weight depression, losing 11% of their original weight. Clinical chemical values indicated renal impairment and some subsequent regeneration in the rabbits. Much less serious kidney damage and hepatic injury in dogs was indicated from biochemical tests performed on both blood and urine. Hematologic results showed definite upward trends in the leukocytic count during the 2nd week of exposure. External symptoms differed in extent in each species. Thus, ocular opacity developed in the dog, mouse and guinea pig whereas the rat developed rales; other species were unaffected externally. The histologic findings showed the effect of the absorption of $BeSO_4 \cdot 4\ H_2O$ through the respiratory tract of the mouse, rabbit and rat to be pulmonary edema. Hepatic injury was observed in mice dying during the 1st 9 da., but not thereafter. Renal changes were found in the rabbit and rat with some regeneration of the tubular eipthelium in the former species. Marked species variation, but good conformity within each species, was observed in the response to the inhalation of $BeSO_4 \cdot 4\ H_2O$. The sulfate ion was felt to contribute significantly to the toxicity of the Be salt. (Author's abstract.)

668. Lisco, H. and Finkel, M.P.: Observations on lung pathology following inhalation of radioactive cerium. Federation Proc. 8:361-1, 1949.

Radioactive cerium (Ce^{144}) is one of the rare earths which is formed in the fission of U and Pu. It is a β-emitter (maximum energy 0.348 Mev.) and it has a half-life of 275 da. Ce^{144} was administered to rats as an aerosol (CeO_2) in doses ranging from 3.2-200 μc./animal. Although the material was deposited generally in all lobes of the lungs, its distribution was not uniform. Radioautographs showed small and large, irregularly distributed foci. A considerable portion of the inhaled Ce remained in the lungs. However, in addition to excretion, some translocation occurred primarily to the liver, kidneys and skeleton. Histologic examinations were made of the lungs of most of the animals, especially those surviving beyond 200 days. The lesions observed will be discussed and illustrated. Particular emphasis will be placed on the occurrence of metaplastic changes in the bronchial epithelium and on malignant tumors arising therefrom. (Author's abstract.)

669. Policard, A.: Experimental researches on the action of some beryllium compounds dust on the lung. In: Proc. 9th Intern. Congr. Ind. Med., London, 1948, 796-7, 1949.

The introduction of dusts of some Be compounds by tracheal injection, by nasal injection during anesthesia or by rotation dusting, which gives a very heavy dusting, into the lungs of >100 rats and guinea pigs produces lesions comparable to those observed in men employed in industries in which these compounds are used. The Be-Na fluoride dusts provoke a very strong irritation with extreme dyspnea, early and violent pulmonary edema, resulting in death of the animals within 24 hrs. The particle size was $\leqq 2\mu$. The BeO dusts, $\leqq 1\mu$ in size, cause hyperplasia of the mesenchymatous cells of the lung tissue. Three types must be considered: a. histiocyte pneumonia; b. granulomatous nodules, frequently with giant cells; c. cellular thickening of the alveolar walls. Arising in a few weeks, the granulomatous nodules persist for several months. They show varying degrees of histological reaction up to their final disappearance. Neither metallic Be nor beryl (Be ore, a Be silicate) has such action: they seem to be harmless.

670. Schmidt, W.: Das Nasennebenhöhlenempyem als Berufskrankheit infolge Staubinhalation. (Empyema of the sinus paranasales as an occupational disease due to the inhalation of dust.) Pract. Otorhinololaryng. 11:282-7, 1949.

In Germany, the granting of compensation in cases of occupational diseases of the upper air passages is confined to those resulting from accidental causes. There is a general agreement among the E.N.T. specialists on the fact that the incidence of diseases of the upper respiratory tract is increasing, especially among the persons exposed to the inhalation of dust during work. Experimentally, 21 rabbits were exposed to the inhalation of pure quartz dust or mixtures of quartz and $CaSO_4$ or CaS, respectively (no proportions are given), as well as quartz and kaolin (75%/25% and 50%/50%, respectively), all exposure being at concentrations of 80 mg./m.^{3} air. The durations of exposure ranged from 34 to 518 da., the inhalation times/day from 1 hr. during "the first few months" to an unspecified, increasing daily exposure during the later mo. All rabbits died due to the inhalations of the dust, and subsequently, sections, frequently serial sections, were done through the entire nose. Of the 21 exposed animals, 12 were found to have developed severe changes in the paranasal sinuses, where the dust easily deposits. 9 were affected on both sides, 3 on one side. The severity of the effect depended upon the lengths of exposure and on variations in individual predisposition. Thus, 4 rabbits did not show any pathologic changes after exposure for 250-450 da., while all others, following an inhalation period of 139-518 da., were severely affected. Histologically, the empyema, very severe in 12 instances, contained dust, dust cells, round cells, desquamation of epithelial and cylindric cells and bacteria. Most of the mucosa was destroyed. The transition from empyema to subepithelial connective tissue layer was characterized by the presence of layers of hyalin, lymphocytes and leucocytes, the deeper layers by edemas and hyperemia. As to the other symptoms described, they were very similar to those observed in cases of empyema of the paranasal sinuses in humans: cartilaginous changes and hyalin degeneration of the subepithelial layers, thickening of the periosteum, as well as changes in the bones.

It is recommended that in cases of empyema of the paranasal sinus, the correlation between dust inhalation and empyema be taken into consideration. It further is suggested that diseases of the kind described above be acknowledged as compensable occupational diseases.

671. Hall, R.H., Scott, J.K., Laskin, S., Stroud, C.A. and Stokinger, H.E.: Acute toxicity of inhaled beryllium. III. Observations correlating toxicity with physicochemical properties of beryllium oxide dust. Arch. Ind. Hyg. and Occupational Med. 2:25-48, 1950.

Acute pneumonitis closely resembling the corresponding disease of Be workers has been observed in laboratory animals (cats, dogs, guinea pigs, New Zealand hares, albino rats and monkeys (total number of animals, 133)) exposed to 4 grades of BeO differing in certain physicochemical properties (notably in ultimate particle size and state of aggregation referable to differences in the kinds of Be compounds from which they were produced by calcination and in the temperature and duration of firing). The mean concentrations of exposure in 6 experiments were 85 mg./m.^{3} ± 15 mg./m.^{3}, and in the 7th, 10 mg./m.^{3}. The grades of BeO used, with their firing temperatures (in C.), and the degree of exposure causing response in animals were as follows: S.P. (1350°), 56 hr. in chamber (3.0 mg.-min./m.^{3} x 10 caused minimal or no histologic damage in lungs, and decrease of red cell count in rabbits; G.C. (1150°), 360 hr. in chamber (18.0 mg.-min./m.^{3} x 10^{-5}) caused no damage in lungs, and macrocytic anemia in rabbits; fluorescent (1150°), for 60-105 hr. in chamber (3.1-5.4 mg.-min./m.^{3} x 10^{-5}) resulted in 5 deaths among rats at shortest and lowest of the exposures, and slight to moderate injury in lungs at the longer and higher exposures; special (400°), for 90 and 236 hr. (4.4 and 1.4 mg.-min./m.^{3} x 10^{-5}) caused minimal to marked damage in lungs, leukocytosis and macrocytic anemia. The average mass-median particle diameter of the S.P. and special grades was $<0.75\mu$, of the G.C., $>1.0\mu$; the distribution of the fluorescent grade showed 41-47% to be $\leq 0.66\mu$ and 90-96% $\leq 1.1\mu$. The injury of the lungs produced by the inhaled fluorescent and special grades was correlated with the smaller ultimate particle size and lesser degree of aggregation of these materials in comparison with the S.P. and G.C. oxides, which failed to cause pulmonary damage even with prolonged exposure. No histologic lesions attributable to toxic action of Be were found in any organs or tissues other than the lungs in any species. Pathologic changes, when observed, were characteristic of an inflammatory response, with intra-alveolar and interstitial edema and mobilization of phagocytes. Bronchial epithelial desquamation and hyperplasia were seen, as well as thickening of the alveolar walls. The most reliable clinical index of Be poisoning observed in these studies has been the development of hematologic changes resembling macrocytic anemia, possibly hypoplastic or aplastic in nature. Correlated with the damage of the lungs in animals exposed to the fluorescent and special grades of BeO were anorexia and loss in weight, dyspnea, lowered arterial O_2 tension and decrease in the albumin-globulin ratio in the blood serum, due to hyperglobulinemia and mild hypoalbuminemia. Other changes included a transient increase of the concentrations of plasma fibrinogen and serum alkaline phosphatase and fluctuations in urinary diastase activity. Determinations of blood nonprotein N and urinary protein consistently yielded normal values. Spectrographic analyses of tissue samples revealed that only a very small fraction of inhaled Be retained was distributed in tissues other than the lungs and pulmonary lymph nodes. The evidence indicates that inhaled BeO dust is removed from the site at which it is deposited in the lungs almost exclusively by phagocytosis.

672. Lushbaugh, C.C., Green, J.W., Jr. and Redemann, E.C.: Effects of prolonged inhalation of oil fogs on experimental animals. Arch. Ind. Hyg. and Occupational Med. 1:237-47, 1950.

Although there are no industries in which oil fogs are a serious hazard and military smoke screening of men with such fogs exposes them for only short intervals, oil fogs would seem to be potential hazards to men operating fog generators or working in constantly screened areas. There is no information available concerning the toxicity of oil clouds for either animals or men. However, there are reports in the literature of approximately 200 cases of lipoid petroleum (mineral oil), which attest to the dangers of oil accumulation in the lungs. 330 mice, 80 rats, 4 rabbits and 13 monkeys were exposed for intervals varying between 100 and 365 consecutive days to fogs composed of oil particles in order that the possible dangers for men working in such atmospheres might be investigated. Ordinary automobile oil and S.G.F. No. 1 oil, the latter used by the U.S. Army Medical Corps for smoke screening troops, were tested. Mice, rats and rabbits were unaffected, and the occurrence of pulmonary tumors in a highly susceptible strain of mice was not accelerated by the oil fog. Surprisingly little oil accumulated in the lungs of the animals, and what was retained was rapidly transferred into the pulmonary connective tissues and lymph nodes. Lipoid pneumonia was found not to be a hazard of living in atmospheres containing 63-132 µg. oil/l. air because the low pulmonary retention enabled the phagocytes of the lung to engulf and remove it adequately. The incidence of infectious pneumonia in monkeys exposed to such fogs was greatly increased, although most monkeys so treated died with severe hyperplastic gastritis as previously reported. (Abst. Davenport, S.J.: U.S. Bur. Mines, 1954.)

673. Policard, A.: Étude du mecanisme de l'action des poussières de glucine sur le poumon des Mammifères. (Mechanism of the action of beryllium dust (glucina) on the lungs of mammals.) Compt. rend. 230:899-901, 1950.

Following the exposure to the inhalation of Be dust, the incidence of a certain pulmonary disease has frequently been observed which still involves several unknown factors. The mechanism of the action of Be dust in the lungs was observed experimentally. Hydrated Be dust in physiologic salt solution was injected both intratracheally and intranasally into guinea pigs under profound anesthesia. The particle sizes (in µ) were determined by electron microscope as follows: <0.2 - 43%, 0.2-0.4 - 46%, 0.4-0.6 - 8% and >0.6 - 3%. The results of the histologic examination, carried out by incineration and dyeing with Ponceau Red, may be summarized as follows: the agglutinated particles (diameter 25-50µ) entering the lungs may conglomerate and subsequently cause atelectasis of the obliterated bronchioles or alveoli. The distribution is not regular. The Be dust deposits in the epithelium of the bronchial mucosa have no necrotic effect. 6-12 da. after the exposure, at a distance of 1.0-14.0 mm. from the exposure site, hypertrophy and hyperplasia of the alveolar walls lead to granulomata resembling those found in pneumopathy in man. Dust particles are not yet found in the cells. There is neither congestion nor exudate of polynuclear leucocytes. After about 2 wk., the Be dust agglomerations in the alveolar parenchyma are "attacked" by histiocytes from the alveoli nearby, thus initiating a process of dissociation and reduction of these deposits which may extend over several months. The intrabronchial and intrabronchiolar deposits as well as the epithelial cells surrounding them detach themselves from the epithelium and move freely within the bronchial lumen. They are most likely expelled by coughing. Histologically, 3 mechanical processes may be

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distinguished which induce the final elimination of the granulomatous nodules: a) sclerosis, b) action of pressure exerted by the near-by bronchioles on the granulomatous cells and c) degeneration of the hypertrophied histiocytes and their elimination from the alveolar cavities.
The experiments have clearly demonstrated 2 facts: (1) The inhalation of Be dust does not cause injuries to the epithelium of the respiratory tract. (2) At a distance from the exposure site, it produces a slow process of hyperplasia and hypertrophy of the histiocytes in the lungs without causing inflammatory reactions, e.g., congestion or local polynucleosis.

674. Shoshkes, M., Banfield, N.G., Jr. and Rosenbaum, S.J.: Distribution, effect and fate of oil aerosol particles retained in the lungs of mice. Arch. Ind. Hyg. and Occupational Med. 1:20-35, 1950.
Albino mice, male and female, were exposed to mists of particulate liquid petrolatum, motor oil, cod liver oil, peanut oil and corn oil, the particles having mass medium diameters ranging from 2.1-2.7μ, and averaging 2.5μ. In the short term studies a total of 18 mice, in groups of 6, were exposed to each oil mist for 2 hr. 2 of each group of 6 were then killed at the following intervals: (1) immediately after exposure to the mist, (2) 48 hr. later, and (3) 96 hr. later, and the lungs were removed and fixed for histologic study. The mice studied for the effects of prolonged exposure were subjected to inhalation of the various nebulized oils in groups of 3-8 for periods varying from 4-8 hr./day, 5 da./wk. and were killed immediately after the last exposure. The duration of these experiments ranged from 2 wk. for 1 series to approximately 1 mo. for the remainder. The general dispersion of droplets of oil retained in the lungs of the mice after exposure was found to be even from apex to base and hilus to pleura. The individual concentration of the retained oil particles varied greatly among groups of mice handled in identical fashion. In each lung the highest concentration of particles was in and around the terminal bronchioles and alveolar ducts. In the statistical analysis of the distribution and the size of corn oil particles retained in the lungs it was found that 80% of all the particles retained in all areas of the lung were ≦2.5μ in diameter. The median diameter, the mass median diameter, and the maximum diameter determined for the particles retained in the bronchi were 1.6, 7.1 and 16.5μ, respectively; in the terminal bronchioles and alveolar ducts, 1.2, 4.6 and 10.0μ and in the alveoli, 0.8, 2.9, 6.0μ. Oil droplets penetrating into the lung are immediately phagocytosed. This process is essentially completed within 48 hr. after aspiration of oil mists except after prolonged exposures varying from 2-4 wk., when large numbers of free droplets are seen in the lungs. The initial concentrations of retained oil droplets of all of the oil mists used were similar. However, during a 96-hr. period of observation, the concentrations of the edible oil droplets (corn, peanut and cod liver oils) decreased progressively, while the concentration of the liquid petrolatum and motor oil droplets remained essentially unchanged. Except for the appearance of scattered macrophages, no acute inflammatory changes were seen in the lungs after a 2 hr.-exposure to the oil mists within a 96-hr. observation period. After heavy exposures, for periods extending from 2-4 wk., liquid petrolatum and motor oil droplet retention resulted in localized foreign body reactions of moderate severity as well as infrequently occurring patches of lipid pneumonia. Cod liver oil droplets caused a moderate foreign body reaction. There were only negligible reactions to peanut and corn oil droplets. It is

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felt that the results of studies of this type performed on mice can be applied to man, for the size distribution of the particles retained in the alveoli of the mice studied agree well with those found in experiments on mice, dogs and monkeys and indirectly on men.

675. Stokinger, H.E., Ashenburg, N.J., DeVoldre, J., Scott, J.K. and Smith, F.A.: Acute inhalation toxicity of beryllium. II. The enhancing effect of the inhalation of hydrogen fluoride vapor on beryllium sulfate poisoning in animals. Arch. Ind. Hyg. and Occupational Med. 1:398-410, 1950.

80 albino male rats were exposed 6 hr./day to either or both 9.2 mg./m.^{3} Be sulfate and 8.5 mg./m.^{3} H_2F_2 in the following manner: 20 to both Be sulfate and to H_2F_2 on alternate days (total-62 hr. for each); 20 to Be sulfate alone daily (total-124 hr.); 20 to H_2F_2 alone daily (total-124 hr.); 10 to H_2F_2 alone on alternate days (total-62 hr.) and 10 to Be sulfate on alternate days (total-62 hr.). Identical mortality rates of 40% occurred in those exposed to Be sulfate and H_2F_2 alternately and in those continually exposed to Be sulfate alone by the 21st day; no mortality attributable to the exposures occurred in the other groups. Similarly, these 2 groups of rats were the only groups to show weights lower than the pre-exposure levels. Loss in weight in the group alternately exposed amounted to 7.5% at the maximal peak; in the group exposed to Be sulfate alone, the maximal peak loss was 4%. Pulmonary edema was noted only in these same 2 groups of rats and was as marked in those rats dying from inhalation of both agents as it was in those dying from inhalation of Be sulfate alone. Deposition of F in tooth and bone was 1.3 times greater in those inhaling Be sulfate and H_2F_2 alternately than in those inhaling similar quantities of H_2F_2 vapor alone. The mechanism by which H_2F_2 vapor enhances Be sulfate poisoning by inhalation in rats is not understood. The possibilities discussed were: F combining with Be in vivo producing a more toxic compound such as BeF_2 or some other related F compound; compensatory reflex hyperventilation and cardiovascular changes, the former for the enhanced Be response and the latter for the increased amount of F^- deposited in bone or H_2F_2 and Be behaving independently in the body, yet giving the appearance of a potentiating action.

676. Stokinger, H.E., Sprague, G.F., III, Hall, R.H., Ashenburg, N.J., Scott, J.K. and Steadman, L.T.: Acute inhalation toxicity of beryllium. I. Four definitive studies of beryllium sulfate at exposure concentrations of 100, 50, 10 and 1 mg. per cubic meter. Arch. Ind. Hyg. and Occupational Med. 1:379-97, 1950.

Acute Be poisoning with pulmonary lesions closely resembling those in man were produced in 11 species of animals exposed 6 hr./day, 5 da./week to inhalation of a Be sulfate mist in concentrations of 100, 47, 10 and 0.95 mg./m.^{3} air. The animals totaled almost 500 and included goats, monkeys, cats, dogs, guinea pigs, rats, mice, rabbits, chickens, hamsters and pigs. No transition of this response to the lesion of chronic granulomatosis developed at any level after more than 3 mo. exposure. The 1 mg. level produced no deaths in any of 7 species exposed for 100 da. Mortality occurred in most of the 11 species at 47 mg./m.^{3} concentration and above. Prolonged exposure at 47 mg./m.^{3} produced greater mortality than shorter exposure at 100 mg./m.^{3}. Increasing the exposure period at 10 mg. level failed to produce this effect. A severe loss of weight occurred in most species (even in surviving animals) at the 100 and 47 mg. levels. Marked gains or weight maintenance or recovery occurred at the 1 mg. level. Various physiological tests indicated that inhaled Be

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Shoshkes, M. et al (continued)
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676. Stokinger, H.E., Sprague, G.F., III, Hall, R.H., Ashenburg, N.J., Scott, J.K. and Steadman, L.T.: Acute inhalation toxicity of beryllium. I. Four definitive studies of beryllium sulfate at exposure concentrations of 100, 50, 10 and 1 mg. per cubic meter. Arch. Ind. Hyg. and Occupational Med. 1:379-97, 1950.

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sulfate produces manifestations other than pulmonary injury and that Be gives rise to a complex set of responses. Among these are anemia, which resembles the macrocytic type, changes of blood cell constituents and disturbances of N_2 metabolism. Changes in arterial O_2 tension and acute inflammatory response in the lung gave evidence of pulmonary injury. Sufficient evidence has been adduced, (a) in the 4 inhalation studies, (b) in control Na_2SO_4 studies and (c) in studies with pure Be metal (intratracheal instillation) that the toxic manifestations observed are the result of the action of Be itself and not mainly the result of the associated anions of its acidic salts. The acute toxic responses have been produced at exposure concentrations and by tissue concentrations of Be far below those usually encountered in chemical toxicity. Amounts of the order of a few mμg. have been found in tissues where changes have been noted. A 100-fold range of Be sulfate mist concentration has been explored and a number of the characteristics of the acute response in animals have been established for periods of exposure varying from 14-100 da. The type of pulmonary responses was little changed by decreasing the concentration from the 100 and 50 mg. levels to the 1 mg. level.

677. Treon, J.F., Dutra, F.R., Cappel, J., Sigmon, H. and Younker, W.: Toxicity of sulfuric acid mist. Arch. Ind. Hyg. and Occupational Med. 2:716-34, 1950.

Groups of experimental animals, usually of 2 or 3 guinea pigs, 5 mice, 2 rabbits and 2 rats, were exposed, in a cylindrical steel chamber, to air bearing given concentrations of a mist of aqueous H_2SO_4 solution. The size of the mist particles were predominantly (ca. 95%) less than 2μ in diameter. The exposure periods lasted no longer than 7 hr. in 1 day; some continued for several consecutive da. Guinea pigs succumbed after having been exposed for a brief period on 1 occasion to such a mist, the concentration of which was 0.0866 mg./l. air (22.1 ppm). Animals of other species survived after being exposed to this concentration for 2.75 hr., and much higher concentrations were required in order to kill them. When subjected to 0.549 mg./l. (140 ppm) for 3.5 hr., some mice died, but exposure to 0.699 mg./l. (178 ppm) for 7 hr. was necessary to kill rats, while higher concentrations were required to kill rabbits. Deaths occurred almost uniformly when groups of mice, rabbits and rats were exposed to a concentration of 0.383 mg./l. (97.6 ppm) for 7 hr. on each of 5 successive da. After being exposed to a concentration of 0.203 mg./l. (51.7 ppm) for a corresponding period, all mice, rabbits and rats survived. The mortality data for groups of guinea pigs, mice, rats and rabbits have been plotted logarithmically in relation to severity of exposure. Rabbits were about as susceptible to the mist of H_2SO_4 as they were to either HCl or H_2F_2, but guinea pigs were somewhat more susceptible to the former than to the latter. Signs of intoxication included rubbing of noses with forefeet, sneezing, coughing vigorously and labored respiration with gasping. Lesions resulting from the H_2SO_4 exposures included degenerative changes of the epithelium of the respiratory tract, pulmonary hyperemia and edema and, in some instances, focal pulmonary hemorrhages. There were, in addition, areas of both atelectasis and emphysema in the lungs of all animals.

678. Dutra, F.R., Largent, E.J., Cholak, J., Hubbard, D.M. and Roth, J.L.: Persistence of beryllium oxide in lungs after inhalation of dust. Arch. Ind. Hyg. and Occupational Med. 4:65-73, 1951.

25 albino rats, divided into 5 similar groups, were exposed to BeO containing a mean concentration of 39.57 μg.Be/l. for 1, 2.5, 5, 10 and 25 hr. for the respective groups. No exposure lasted longer than 5 hr./day. The dust particles had a mean diameter of 0.285μ, with a range of

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0.11-1.25 μ. At the end of the exposure, the animals were killed and their tissues prepared for analysis. Definite precautions were taken against contamination from external sources of Be. In a 2nd experiment, 40 rats were exposed to a similar dust of BeO at the same concentration for 5 hr./day, on 7-da. Some were killed right after the final exposure and the rest died or were killed at varying periods up to 582 da. The results of the 1st experiment showed that after only 1 hr. exposure the lungs contained appreciable amounts of Be, i.e., 0.80-10.4 mg. Be/100 g. Multiple periods of exposure resulted in both greater and more variable pulmonary concentrations of Be; at 25 hr., the range found was 7.06-53.6 mg. Be/100 g. lung. In the 2nd experiment, at the end of the 7 da. exposure and for the 582 da. thereafter the pulmonary concentrations of Be remained high, up to 86.0 mg. Be/100 g. in the 1st wk. after cessation of exposure. The Be content gradually decreased as the period after exposure increased. There was little tendency for the Be to be redistributed from the lungs to other tissues as analyses of the other organs showed negligible amounts for the most part; the highest was 54 μg. Be/100 g. carcass. Microscopic examinations of tissues of those rats killed immediately after the last exposure showed numerous visible granules of highly refractile dust in the lungs and evidence of tissue reaction to this dust. There was little change in the appearance of the lung tissues during the 1st 35 da. following the cessation of exposure, with the exception that the animals killed at the end of 35 da. had flattened septal cells. The situation persisted with little change through the 582 da. during which some of the animals remained alive. In some of the older animals there were obviously fewer aggregations of mononuclear cells containing dust, and some of the old rats showed considerable fibrosis in the areas around the dust cells. This reaction does not resemble chronic pulmonary berylliosis in man.

679. Hall, R.H., Laskin, S., Frank, P., Maynard, E.A. and Hodge, H.C.: Preliminary observations on toxicity of elemental selenium. Arch. Ind. Hyg. and Occupational Med. 4:458-64, 1951.

An investigation was made of 2 Se operations representing pilot models of large-scale industrial processes. Day-long sampling of air at waist level 10 ft. from an operating unit gave values ranging from 0.007-0.025 mg. Se/m.^{3}. Urinalysis of 24-hr. specimens of the workers showed Se concentrations within the normal range of 0-0.16 ppm.

Young female albino rats in 4 groups of 5 each were exposed to a Se fume, set up in a small bell jar, for 2, 4, 8 and 16 min., respectively. The fume was produced by vacuum evaporation of small chips of Se heated in a cone shaped from a filament of W. The concentration was unknown but thought to be much higher than any occurring in industrial processes. One animal from each group was killed 1, 2, 4, 8 and 16 da. after exposure. The lungs grossly exhibited moderate to severe hemorrhage with scattered emphysematous and atelectatic areas consistent with the diagnosis of mild to moderate pneumonitis. Little repair was noted 16 da. after exposure. It is possible that the fume was contaminated with Se oxide, known to be toxic; however, no gross contamination was noted. 20 rats, 10 guinea pigs and 6 rabbits were exposed to atmospheres containing ca. 33 mg. Se/m.^{3}, mean diameter-1.2μ. The rats were exposed for a total of 8 hr. 2 died 48 hr. and 7 da. later, respectively; the lungs showed only hemorrhagic injury. The surviving rats on autopsy showed mild interstitial pneumonitis. The guinea pigs and rabbits were exposed for a total of 16 hr. None of the animals lost weight and showed signs of toxic effects and there were no deaths. Histologic

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Hall, R.H. et al (continued)
examination of 2 of each species 1 wk. after exposure showed mild chronic interstitial pneumonitis, and some pulmonary congestion in the guinea pigs. The remaining animals were killed 3 wk. after exposure. Varying degrees of congestion were seen in all lung sections; mild congestion of liver and spleen also occurred in some of the guinea pigs. The LD_{50}'s of a number of Se compounds known to be toxic are listed.

10 male albino rats were given a suspension of 25 mg. powdered gray Se/ml. intraperitoneally. 2 rats each received doses ranging from 200-1,000 mg./kg. body weight. Autopsies showed no gross abnormalities of the organs.

Powdered gray Se applied to the skin of 5 M and 5 F adult guinea pigs gave no evidence of primary irritation or of sensitization.

680. Smith, W.E., Sunderland, D.A. and Sugiura, K.: Experimental analysis of the carcinogenic activity of certain petroleum products. Arch. Ind. Hyg. and Occupational Med. 4:299-314, 1951.

Thirty white male albino mice were used for each sample of the high boiling fraction of a catalytically cracked oil tested. The mice were painted with the sample 3 times/wk. in the suprascapular region until they died (from 160-450 da.). At each painting ca. 15 mg. of material were deposited on the mouse. The carcinogenic potency of this oil was found comparable to some of the most active coal tars described in the literature. When the data were assembled, tumors had been induced in 1,458 of 6,990 mice whose skins had been painted. Of the 1,458 tumor-bearing mice, 1,183 had died; at the time of death 455 had carcinomas and 728 had only benign papillomas. The characteristic microscopic feature of the benign papillomas was the prominent but benign hyperplasia and hyperkeratosis of the epithelium. The majority of the microscopically proved carcinomas were of the squamous type with prominent epithelial-pearl formation. The carcinogenic activity of the petroleum oils was found in the fractions boiling above 700°F. The carcinogenic material was contained in the aromatic components of these oils. Non-aromatic fractions were essentially noncarcinogenic. Laboratory fractionation showed that the most potent material distilled between 800 and 1010°F. Within this range no considerable segregation of carcinogenic activity was achieved by narrower temperature cuts, which suggests that more than 1 carcinogenic compound was present. Fractions distilling below 700°F. were essentially noncarcinogenic. The carcinogenic activity of potent oils was reduced by diluting these with noncarcinogenic oils. Blends containing not more than 10% of catalytically cracked oil distilling above 700°F. usually failed to elicit cancers. Mild hydrogenation or treatment employing 0.8-2.2% by weight of 93% and 98% H_2SO_4 had no significant effect on the carcinogenicity of an oil. Unrefined "slack waxes" induced occasional benign papillomas and a few cancers after prolonged painting. Aromatic extracts of such waxes were, however, much more active. Therefore, the carcinogenicity of "slack waxes" is attributed not to the paraffins but to aromatic components of the oils from which they were pressed. The aromatic components are removed in the further purification of waxes for marketing. Tars prepared from petroleum by cracking processes exhibited varying degrees of carcinogenic activity, but none were as potent as a high temperature coal tar. Samples obtained in an experimental retorting of Colorado shale oil elicited tumors, both benign and malignant, in a small percentage of animals tested, but from the 550°-700°F. fraction only.

681. Stokinger, H.E., Steadman, L.T., Wilson, H.B., Sylvester, G.E., Dzuiba, S. and LaBelle, C.W.: Lobar deposition and retention of inhaled insoluble particulates. Arch. Ind. Hyg. and Occupational Med. 4:346-53, 1951.

Ten albino male rats were exposed at each of these conditions: 84 mg. U_3O_8 dust (MMD-2.6μ)/m.^{3} air for 1 day (6 hr.) and for 9 da. (54 hr.) and 84 mg. UO_2 dust (MMD-0.45μ)/m.^{3} air or 1 day (6 hr.) and for 9 da. (54 hr.). Approximately 40 additional rats were exposed in groups of 20 each for 54 hr. to each dust and were held for 1.5-8 mo. after termination of exposure before being killed. After the rats were killed, their lungs were immediately removed, the 5 lobes were dissected and after gentle blotting were individually weighed to the nearest mg. The U content of each lobe was determined to the nearest 0.1 μg. and the deposition and retention calculated. 3 lobes (left, right inferior and right postcaval) had similar rates of deposition (21.9-23.7 μg. U/g. lung tissue for U_3O_8 and 224-241 for UO_2) and elimination (47-52 for U_3O_8). The superior right lobe differed in that deposition occurred at a faster rate (150-175%) than in any other lobe. At 10 da. after the start of exposure this lobe's elimination of U was double (106 μg. U for U_3O_8) that of other lobes on the basis of unit weight of lung tissue. The median right lobe also differed from the others; no elimination was detectable in a 10-day period. Nevertheless, greater amounts, both absolutely and percentagewise, were removed from the right lung than from the left after exposure irrespective of particle size. From the finding that 10 times greater amounts of U were deposited in the alveolar spaces with UO_2 of MMD 0.45μ than were deposited with U_3O_8 dust of MMD 2.6μ and the knowledge of the atmospheric concentrations of the 2 dusts at stated particle sizes, it was possible to estimate that the nasal filtration cut-off point in mass-median diameters was about 0.7μ for the rat. Alveolar deposition was calculated to be but 0.9% for U_3O_8 of 2.6μ MMD based on respired atmospheric concentrations of particles of all sizes of this distribution; for UO_2 at MMD 0.45μ, alveolar deposition was 8.3%.

682. Valada, P.: Sur la toxicité des vapeurs nitreuses. (Toxicity of oxides of nitrogen.) Mem. poudres 33:487-90, 1951.

The inhalation of nitrous fumes may cause two types of poisoning: a) acute, characterized by an insidious onset (several hours after the exposure), with symptoms of respiratory disorders, acute pulmonary edema and cardiovascular changes, fatal in 2/3 of the cases and b) chronic, manifested mainly by irritations of the air passages and asthenia. The complex physiopathologic picture is characterized by 3 modes of action: acute pulmonary edema, caused by changes in the pulmonary parenchyma similar to those produced by suffocating substances, formation of methemoglobin and finally, at high concentrations of nitrous fumes, severe globulysis, vasodilatation and hypotension. The typical symptoms are: asphyxia, accompanied by cyanosis, pallor and a weak pulse; the effects on the respiration are described as follows: following polypnea, the patient shows bradypnea and, subsequently, apnea.

Experimentally, ampuls containing oxides of N (from the action of HNO_3 on Cu) were broken in an inhalation chamber, and the effect of 0.5 hr. exposure was observed in a dog, 2 rabbits, 4 guinea pigs and 5 rats (no weights are given) at the following concentrations: 300, 400, 500 and 1,000 mg./m.^{3}. According to the tabulated data, the following MLD's lead to death within the times given: for the dog, 1.0 g./m.^{3}, at 6 hr.; for rabbits, 400 mg./m.^{3}, at 4 da.; for guinea pigs, 300 mg./m.^{3}, at 3 da.; for rats, 300 mg./m.^{3}, at 5 da. after the exposure. The animals demonstrated mainly respiratory symptoms. The dog showed dyspnea, abundant salivation, foamy, bloody nasal secretion and cyanosis of the buccal

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mucosae. Macroscopically, the main changes observed were pulmonary edema, similar to that caused by $COCl_2$, hepatic degenerations and renal congestions. Microscopically, the lungs, liver, kidneys and spleen showed deposits of ferruginous pigment, indicating severe globulysis. The latter findings provided indications for the therapy of poisoning due to nitrous fumes.

683. Vintinner, F.J.: Effect of aluminum dust on susceptibility to lobar pneumonia--animal experiments. Arch. Ind. Hyg. and Occupational Med. 4:217-20, 1951.

Rats were exposed in a dust chamber for 6-110 da., 8 hr./day, to air containing metallic Al dust and then were inoculated intrabronchially with Type I pneumococci suspended in either mucin or broth. Control rats similar in age, sex and weight were treated in the same way except for exposure to Al dust. The Al dust ranged from 300-1,000 million, with an average of 800 million, particles/ft.^{3}; all were $<5\mu$ and 90% were $<3\mu$ in size. In the mucin experiment, the mortality was lower for the dust-exposed group than for the controls. The 61-da. exposure showed a significant difference,and also when all the experiments in which the dust exposure lasted 24 da. or longer were combined, the difference in mortality was significant. The total incidence of infection and % fatality therefrom also were lower in the dust-exposed group than in the controls. In the broth experiment, the response was chiefly a rapidly developing septicemia rather than local consolidation. Here the mortality rate of the dust-exposed rats was, in general, higher than that of the control rats. The difference in mortality was statistically significant in 1 experiment of 45 da. and also when the experiments of 30 and 45 da. exposure were combined. No difference in the incidence of gross pathological changes in the lungs of rats exposed for 80 and 110 8-hr. days were found. The incidence was 26.7% in both the exposed and control rats for the 110-day experiment and 13.3% for the 80-day experiment. The control rats gained only slightly more weight than the dust-exposed rats in both experiments.

684. Vintinner, F.J. and Baetjer, A.M.: Effect of bituminous coal dust and smoke on the lungs--animal experiments. I. Effects on susceptibility to pneumonia. Arch. Ind. Hyg. and Occupational Med. 4:206-16, 1951.

A review of the literature shows that there is little evidence to support or deny the contention that inhalation of coal dust and smoke may predispose to pneumonia. Exposing rats, ca. 160 in all, to 400-850 million particles of bituminous coal dust/ft.^{3} air, for various periods of time ranging 5-165 da., did not increase their susceptibility to lobar pneumonia produced by intrabronchial injection of Type I pneumococci suspended in mucin. In fact, the mortality rate and the incidence of infection were lower in the rats exposed to the dust than in the control groups (ca. 165 rats). When the organisms were injected in a broth medium into the rats (ca. 160), no very consistent or significant difference in mortality rate existed between the dust-exposed and the control groups. Exposing rats for long or short periods of time (2-154 da.) to smoke equivalent to ca. no. 3 Ringelmann Chart reading produced by the combustion of bituminous coal did not alter their susceptibility to Type I pneumococci when these organisms were injected intrabronchially in either broth (140 exposed and 150 control rats) or mucin (255 exposed and 260 control rats).

685. Worth, G. and Schiller, E.: Die Filterfähigkeit der Tiernase im Staubinhalationsversuch. (The filtering capacity of the nose of animals in dust inhalation experiments.) Arbeitsphysiol. 14:407-12, 1951.

Although there are countless variables in experimental animal exposure to the inhalation of dust, standardization is still lacking with regard to both procedures and reporting. The following factors are mentioned: 1) the nature of the inhaled dust, i.e., the number of particles/cm.^{3}, the particle size distribution/unit volume, the chemical composition of the dust, the mineralogic nature of the particles; 2) the quantitative and qualitative filtering by the nose and the other upper air passages; 3) the reaction of the organism and secondary infections, especially t.b. A review of publications on the subject shows that the authors place varying degrees of significance on modifying factors, such as differences in breed (extent of the filtering capacity due to the length of the nose) of the inhaling animals; nose or mouth breathing in the prevention of or susceptibility to dust diseases of the lungs, especially silicosis; the velocity and pressure of the air flow.

The filtering capacity of the nose of experimental animals inhaling dust was measured in 4 rabbits and 4 (short-nosed) dogs (no weights are given). The dust mixture was continuously sucked off by means of tracheal canula, the animals being narcotized with Evipan. Measurements of the dust concentrations before entering and after leaving the nose (averaging 13 measurements/experiment) were done simultaneously by use of 2 "konimeters" and 2 tyndallometers. The durations of the exposures averaged: for the rabbits, 11 min.; for the dogs, 9.5 min. The tabulated results indicate that the average amounts of dust of $<2\mu$ particle size retained in the nose of the exposed animals were: for the rabbit, 84.9 ± 5.3%; for the dog, 34.0 ± 9.1%. Due to the lower filtering capacity of the nose of the dogs, these animals would prove more suitable in the experimental production of pneumoconioses.

686. Amdur, M.O., Schulz, R.Z. and Drinker, P.: Toxicity of sulfuric acid mist to guinea pigs. Arch. Ind. Hyg. and Occupational Med. 5:318-29, 1952.

The apparatus used in exposing the guinea pigs to H_2SO_4 mist is illustrated. Mean particle size was determined to be ca. 1μ which is comparable to 0.75μ, the H_2SO_4 particle size found in Los Angeles atmosphere. Two groups of guinea pigs were exposed for 8-hr. periods. LD_{50} for 38 guinea pigs 1.5 yr. old was 50 mg. H_2SO_4/m.^{3} air, and LD_0 was 20 mg./m.^{3} concentration. For 62 guinea pigs 1-2 mo. old, LD_{50} was 18 mg./m.^{3}, and LD_0 was 8 mg./m.^{3}. The difference in LD_{50} for the young and old groups is statistically significant. Autopsies were performed immediately on the animals that died during exposure. Gross observation showed areas of hemorrhage in the lungs, nose (at higher concentrations) and adrenal glands, while other organs appeared normal. Microscopically, the lungs revealed hemorrhage and edema. More detailed observations are given. Animals surviving exposure were killed at various intervals up to 3 wk. Grossly, the lungs of these animals disclosed spotty areas of consolidation. Histologically, these lungs showed a general picture of pneumonic changes and fibrosis. Guinea pigs 1-2 mo. old were exposed for continuous periods up to 72 hr. No mortality occurred at a concentration of 8 mg. H_2SO_4/m.^{3} air up to 72 hr. exposure. The mortality rate changes very little at concentrations of 12 and 16 mg./m.^{3} for exposures lasting from 8-72 hr. At concentrations $\geqq 20$ mg./m.^{3}, mortality rates increased rapidly. The surviving animals were killed at various intervals up to 3 wk. after the end of the exposure period. The changes were of the same type as those found in the 8-hr. exposures. Photomicrographs comparing lung section of controls and animals exposed for 8 hr. and for 72 hr. are given.

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The 2 distinct toxic actions of H_2SO_4 mist are discussed. H_2SO_4 mist produces laryngeal spasm and also causes deep-seated damage of the lungs. The 1st action is the immediate cause of the high mortality rate. This action depends on concentration of H_2SO_4 much more than on time of exposure. The severity of the lung damage is dependent on total dosage rather than on concentration alone. A concentration of 8 mg./m.^{3} given for 72 hr. (concentration X time=576) produces much more extensive lung damage than does a concentration of 20 mg./m.^{3} given for 8 hr. (concentration X time=160), although no mortality is produced by the 1st dose and 50% mortality is produced by the 2nd dose. The lung damage is still observed as long as a mo. after a single exposure.

687. Falk, H.L. and Steiner, P.E.: Adsorption of benzpyrene and pyrene. Cancer Research 12:40-3, 1952.

The adsorption of 3:4-benzpyrene and pyrene on 10 different C blacks with an average particle diameter varying from 10-80 mμ was found to be inversely proportional to particle size. For 3:4-benzpyrene, 200 μg. was completely adsorbed on 100 mg. of the smallest-sized C black (10 mμ); when 500 μg. was added, only 1 μg. was detected in solution. In the largest-sized C black (80 mμ), not only was adsorption not observed, but actual elution of part of its own content of 3:4-benzpyrene occurred. The elution of these hydrocarbons from the C blacks depended on the nature of the black, the nature and volume of the solvent and the temperature. With each extraction only a fraction of the total adsorbate could be eluted. It is suggested that the observed difference in quantity of aromatic hydrocarbons extracted from channel and furnace blacks is due to greater adsorption on the former than on the latter. The adsorption phenomenon may also play a significant role in the understanding of the low carcinogenicity of soot in man. Other possible applications are also discussed.

688. Falk, H.L. and Steiner, P.E.: The identification of aromatic polycyclic hydrocarbons in carbon blacks. Cancer Research 12:30-9, 1952.

Benzene extracts of some C blacks were found to contain 3:4-benzpyrene, a strong carcinogen for animals; 1:2-benzpyrene, a weak carcinogen and 5 other related aromatic hydrocarbons: pyrene, fluoranthene, 1:12-benzperylene, anthanthrene and coronene. Furnace blacks, with an average particle diameter of 80 mμ or more, possessed all 7 of the aromatic hydrocarbons; those with particle size <50 had few or none. A rough correlation existed between yield of extractable aromatic hydrocarbons and average particle diameter of the C blacks. These hydrocarbons were not detected in any channel blacks, which have small particle diameters averaging from 10-30 mμ, and are made by a different process. Based on these observations an interpretation of the apparently contradictory reports in the literature on the carcinogenicity of soot is possible. 3:4-Benzpyrene seems to be the principal carcinogenic agent. This hydrocarbon can be extracted from many soots with lipid solvents, and these extracts produce tumors in animals at the site of application. Soot itself appears to be carcinogenic on skin but possibly not on respiratory tract epithelium. It is suggested that this difference in behavior is explained by the presence of lipid solvent (the sebaceous secretions) in the skin and its absence in the respiratory tract. It is further suggested that the differences in extractable aromatic hydrocarbons from C blacks can be explained by the phenomenon of adsorption. (Condensed authors' summary.)

689. Gray, E.LeB., MacNamee, J.K. and Goldberg, S.B.: Toxicity of NO_2 vapors at very low levels. A preliminary report. Arch. Ind. Hyg. and Occupational Med. 6:20-1, 1952.

Forty rats, 10/group, were exposed 4 hr./day, 5 da./wk. to the vapors of red fuming HNO_3 containing 9-14 ppm NO_2. The total length of exposure varied from 40-96 hr. for the various groups. Animals examined shortly after the period of exposure exhibited an inflammatory condition throughout the entire respiratory tract. The upper portion of the tract was more severely affected, there being evidence of severe rhinitis and tracheitis, with less severe pneumonitis. In many of the animals killed 8 or more wk. after exposure the inflammatory process had subsided, but there were localized areas of emphysema in all lobes of the lung. With the exception of moderate congestion, liver, spleen, kidney and brain showed no pathological changes. The changes observed in these animals did not develop in accordance with the length of exposure, there being no difference between rats exposed for 40 hr. and those exposed for a longer period. It is considered, from these experiments, that a MAC of 25 ppm or more is too high.

690. Kotin, P.: Organization and operation of a study of air pollution in relation to experimental carcinogenesis. Arch. Ind. Hyg. and Occupational Med. 5:548-53, 1952.

This article describes the purposes, methods and apparatus of the study which was initiated in an attempt to determine the role, if any, of hydrocarbon air pollutant by-products of petroleum refining, distribution and use in experimental carcinogenesis. Three aspects studied are: (1) collection of samples, (2) biological experimentation and (3) identification of hydrocarbon constituents of smog. Whole smog samples are obtained either by direct air sampling on smoggy days or by collection of samples of artificial smogs created by ozonizing gasoline in a transparent plastic chamber. Mass spectrograms of constituents of both type smogs show markedly similar patterns. The specially designed filter which can collect particulate and gaseous phases both simultaneously and independently is described and illustrated. Individual sources of hydrocarbons emitted into the air in order of their contribution are: (1) transportation (gasoline and diesel engines), (2) petroleum refining, (3) petroleum production and (4) petroleum marketing. Samples representative of the 1st source are collected directly from gasoline and diesel engine exhausts during the starting of a cold engine, during periods of uniform running, during periods of acceleration and stress. Samples representing the 2nd source are obtained by means of bag or precipitron collecting units and used in soot form. Samples representing the 3rd and 4th sources could not easily be collected; their effects are included in the studies on whole smog.

Mice of both sexes of C57 black strain, A strain and C3H strain are being used for the biological tests. Benzene solutions and suspensions of the particulate matter and of the gaseous material adsorbed onto C black from whole smog, from gasoline and diesel engine exhausts and from industrial installations at their source are painted semiweekly onto the mice in the interscapular region. Some of the gaseous material is collected directly into tricaprylin and injected subcutaneously into the lumbar area of the mice. Control groups of animals using benzene, tricaprylin and C black are being treated in the same ways.

Standard chromatographic and spectrophotometric procedures are being used for the identification of individual hydrocarbons extracted from the Los Angeles atmosphere.

691. Nau, C.A., Neal, J. and Freund, A.P.: An automatic dust feed apparatus useful for exposure of animals to dusty atmospheres. Texas Repts. Biol. Med. 10:874- 82, 1952.

The improvements of this automatic dust feed apparatus over the earlier model are described and illustrated. The apparatus can create dust concentrations which, in the authors' opinion, could be kept at the same level for years without any significant fluctuations. With this equipment uniform temperature and humidity can be maintained and sufficient dusty air can be produced to supply a room 6'x10'x8' in which various species of animals can be exposed.

692. Roshchin, I.V.: (Hygienic characteristics of industrial vanadium aerosol.) Gigiena i Sanit. 11:49-51, 1952.

The dust produced when smelting the slag for V extraction may reach a concentration of 50 mg./m.^{3} air and may contain up to 5 mg./m.^{3} NH_4 vanadate. V_2O_5 is derived from NH_4 vanadate and, in turn, has to be smelted before being used in the production of ferrovanadium, during which process V aerosol evolves. It was detected in the smelting room at concentrations ranging from 1.2 to 16.5 mg./m.^{3}, the particle sizes not surpassing 2 µ.

The temperature of the electric arc in ferrovanadium-smelting electric furnaces (3,200^o, not given but most likely C.) surpasses by far the melting point of the lower V oxides ($<$2,000^o) and particularly that of V_2O_5 (658^o). In the vicinity of the furnaces, the dust concentrations may reach 67.7 mg./m.^{3} and contain up to 0.3 mg./m.^{3} V_2O_5 and up to 0.45 mg./m.^{3} lower V oxides.

In several experiments extending over 2-4 mo., white mice inhaled V_2O_5 aerosol at 0.003-0.03 mg./l. air and ferrovanadium aerosol at 1.0-2.0 mg./l. air. During the 3rd mo. of exposure, the mice inhaling the former showed increasing weight loss and marked, blood-containing nasal secretion. A 1-hr. exposure to V_2O_5 aerosol at 0.08 mg./l. air caused acute toxic effects, while ferrovanadium did not produce acute effects even at 10.0 mg./l., owing to the slow transfer of V into the biochemical reactions. On autopsy, microscopic examinations of the experimental mice revealed plethora and dilatation of the blood vessels and stasis of the capillaries, perivascular edema, lymphostasis in the lungs and changes in the cerebrum, due to insufficiency in blood supply. Ferrovanadium aerosol caused chronic, productive pneumonia, while the changes produced by V_2O_5, much more pronounced in nature, may be summarized as follows: severe injury of vascular and lymph systems, serous, desquamating bronchitis and occasional peribronchial sclerosis. The author states that the degree of toxicity of the substances studied depends not only on their chemical but also on their physical qualities, e.g., V_2O_5 aerosol of very fine particle size produced much severer effects than did that of coarser particle size. The following LD's were established for the animals: V_2O_5, 0.7-0.8 mg./l. air, NH_4 vanadate, 1.0-1.3 mg./l. air. As MAC's, the following concentrations are suggested: V_2O_5 aerosol (particles) - 0.0001 mg./l., V_2O_5 aerosol (droplets)-0.0005 mg./l., V salt solutions - 0.0005 mg./l. and ferrovanadium dust - 0.001 mg./l.

693. Goetz, A.: Application of molecular filter membranes to the analysis of aerosols. Am. J. Public Health 43:150-9, 1953.

The properties of molecular filter (MF) membranes are reviewed with particular emphasis on the properties suitable for the analysis of aerosols, viz., the flow characteristics, the effective pore size and the optical properties. The performance of MF in aerosol analysis is discussed. With pure fumes, particle retention is practically complete. With smokes or

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other liquid aerosols, clogging of the pores occurs. However, in field tests when both smoke and fumes were filtered through MF membranes (at 60-80 mg./1,000 ft.^{3}), practically quantitative retention of most smoke and all fume components was obtained with no indication of clogging. Evaluation of radioactive atmospheric constituents was made by similar experiments. Performance of MF membranes with microbiological aerosols is also discussed.

694. Haagen-Smit, A.J., Bradley, C.E. and Fox, M.M.: Ozone formation in photochemical oxidation of organic substances. Ind. Eng. Chem. 45:2086-9, 1953.

Experiments in which O_3 is formed by the action of sunlight on low concentrations of (1) NO_2 and 3-methylheptane, (2) N oxides and a series of straight chain organic acids, (3) N oxides and several olefins, alcohols and aldehydes, (4) NO_2 and caprylic acid and (5) NO_2 and 10°C. fractions of ethyl gasoline are reported and the results tabulated. The results show substantial formation of O_3 (ca. 0.5-1.0 ppm) from concentrations of ca. 1 ppm hydrocarbon and ca. 0.4 ppm N oxides. O_3 was also found to be produced by photochemical oxidation of biacetyl, bibutyryl, pyruvic acid and butyl nitrite without N oxides. The O_3 produced in these reactions was identified by chemical and physical methods. The O_3 formation is attributed to a peroxide radical chain reaction in which atomic oxygen is released to form O_3 with molecular oxygen.

The release of large quantities of hydrocarbons to the air and the simultaneous presence of N oxides from combustion processes explains the relatively high O_3 content, and consequent severe rubber cracking, in the Los Angeles area. In view of the irritating properties of the products formed by this photochemical oxidation, both hydrocarbons and N oxides should be considered as potential irritants when they occur simultaneously in the air at low concentrations.

695. King, E.J., Mohanty, G.P., Harrison, C.V. and Nagelschmidt, G.: Effect of modifications of the surface of quartz on its fibrogenic properties in the lungs of rats. 1. Quartz leached with Ringer's solution. 2. Quartz etched with hydrofluoric acid. 3. Quartz coated with coal extract. Arch. Ind. Hyg. and Occupational Med. 7:455-77, 1953.

Physiochemical studies have shown that the outside of each quartz grain consists of an amorphous SiO_2 layer of higher solubility, and the core, of quartz of lower but still measurable SiO_2 solubility. Experiments were undertaken to compare the fibrogenic effects of quartz on the lungs of rats (by intratracheal injection of 0.5 ml. of dust suspension), before and after stripping the amorphous layer slowly by leaching with Ringer's solution, or quickly by etching with HF. For the latter, the following samples were used: (1) control quartz (0.5-1μ) plus 0.015% HF. i.e., 7.5μ HF per rat; (2) HF-extracted sample (heated with Analar HF, then washed repeatedly) after washing it several times with isotonic saline and (3) sample of HF-extracted quartz after electrodialysis. Stripping with Ringer's solution reduced the silica solubility to 10% of its original value, but had no effect on the fibrosis which reached stage 5 (Belt and King's classification) with sample and controls equally in 5 or 6 mo. Etching with HF, however, greatly enhanced the fibrogenic reaction. All degrees of fibrosis up to confluent fibrosis (stage 5) were reached in less than a mo.; 18 out of 25 animals died within 2 wk. and none survived 48 da. The controls gave stage 3 fibrosis as the maximum within 3 mo., just as did the 2 samples in the Ringer series. A similar, although not quite so rapid, reaction could be produced by adding a small amount of HF

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(0.015%) to the unetched quartz control. Washing the etched sample with saline and electrodialysis weakened the extra effect. The dusts were also administered by intraperitoneal injections to 5 rats and 8 white mice, at 1 ml. of the individual suspension/rat and 0.5 ml./mouse (50 mg. and 10 mg., respectively). These experiments did not show such strong differences as the results in the lungs, although they were in qualitative agreement. As these were only preliminary findings, no definite statements were made as to the enhanced fibrinogenic effect. The possibilities of the effect being due to F or to the quartz particles having acquired highly fibrogenic surface properties due to a defect lattice are discussed. The main conclusion is that removal of the amorphous layer does not reduce, and may enhance the fibrogenic action of quartz and that in samples of this type there is no parallelism between silica solubility determined in the test tube and fibrogenic effect in animals. Coating the quartz with coal did not appear to modify its action.

696. Amdur, M.O.: Effects of a combination of SO_2 and H_2SO_4 on guinea pigs. Public Health Repts. (U.S.) 69:503-6, 1954.
Eight guinea pigs were exposed for 8 hr. to a combination of 8 mg./m.^{3} H_2SO_4 mist (mean diameter-1μ) and 89 ppm SO_2. 2 of these animals were re-exposed 4 da. later to the same concentrations for another 8 hr. In previous research by Amdur et al.(Arch. Ind. Hyg. and Occupational Med. 5:318-29, 1952), 68 guinea pigs were exposed for 8 hr. to 8 mg. H_2SO_4 mist/m.^{3} and 30 animals for 72 hr. to the same concentration. For SO_2 controls, only 4 guinea pigs were exposed to 89 ppm SO_2 in this experiment due to limiting factors. However, the response of these 4 corresponded to that reported by Weedon et al. (Contrib. Boyce Thompson Inst. 10:281-324, 1939.). In cases of exposure to H_2SO_4 alone (8 mg./m.^{3}) or to SO_2 alone (89 ppm), growth was stopped on exposure but resumed quickly thereafter, even for the 72-hr. exposure to H_2SO_4. However, growth was slow to resume after exposure to the combination of H_2SO_4 mist and SO_2 and the 2 animals re-exposed ceased to grow entirely during the period of observation after re-exposure. Examinations of the lungs showed slight damage after exposure to either of the 2 alone at the above concentrations, but extensive damage after exposure to the combination of the 2, with severity of damage increasing with exposure. In the latter cases, the damage consisted of large areas of complete consolidation and hepatization involving entire lobes. Outwardly, the animals breathed and behaved normally even at high concentrations and at long exposures of either of the 2 separately, but became progressively ill with frothing at the nose and mouth and dyspnea after 1 hr. exposure to the 2 substances together, and the dyspnea continued 24-48 hr. after cessation of exposure.

697. American Cyanamid Company: Toxicology of Acrylonitrile. New York, 1954, 16 pp.
A summary of toxicity data on acrylonitrile by various routes. In particular, it contains a table summarizing the inhalation studies made on several test animals (dog, rat, monkey, cat, guinea pig and rabbit) in both single and repeated exposures, with the sources included. Treatment, in case of intoxication, is described. 15 references in all are given.

698. Cameron, G.R.: Toxicity of chlorosulfonic acid-sulfur trioxide mixture smoke clouds. J. Pathol. Bacteriol. 68:197-204, 1954.
Two goats, 12 rabbits, 12 guinea pigs and 20 rats were exposed to a chlorosulphonic acid--sulfur trioxide smoke cloud containing 60 mg. SO_3/m.^{3} for 6 hr./day for 9 da., and to a preliminary concentration of

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Cameron, G.R. (continued)
30 mg. SO_3/m.^{3} for 6 hr. 1 monkey and 20 mice were exposed to 60 mg. SO_3/m.^{3} in such a cloud for 7 da. In a 2nd experiment, 1 monkey, 2 goats, 20 guinea pigs, 20 rats and 20 mice were exposed to a cloud containing 30 mg. SO_3/m.^{3}, 6 hr./day for 14 da. The mean HCl content of these clouds was ca. 6%. Survivors at the end of the experiments were autopsied. The only animals to show symptoms during exposure were the guinea pigs. There was some coughing by the goats during the experiments, but that was never severe. The eyes did not appear to be affected. No animals lost weight. No deaths occurred among the monkeys, goats or rabbits exposed for 42-84 hr. to 30 or 60 mg./m.^{3}. However, 11 out of 12 guinea pigs exposed for different periods to 60 mg. died and 10 out of 20 exposed to 30 mg. died. Rats and mice survived 7-9 6-hr. exposures of 60 mg. and 6-14 6-hr. exposures of 30 mg. In the fatal cases the following pathological changes were noted. The heart was invariably enlarged. The lungs were greatly distended with air, and large areas of collapse, congestion and edema were indicated. However, there was no tracheal damage. The liver was unusually enlarged, dark red in color and extremely congested and soft. The kidneys were pale, soft and swollen, with the typical appearances of cloudy swelling or fatty change. The adrenals were usually mottled with scarlet congested blood vessels or small hemorrhages. The blood clotted rapidly, was dark in color and sedimented quickly, giving a buffy clot. Some of the survivors of the repeated exposure group showed evidence of injury to their lungs but their other organs remained normal. It is concluded that persons not subject to pulmonary disturbance should prove resistant to chlorosulphonic acid smokes in relatively low concentrations in open air. A hazard may, however, exist in human beings who suffer from asthma and allied conditions. High concentrations are not harmless.

699. Cember, H., Hatch, T.F., Watson, J.A. and Grucci, T.B.: Pulmonary penetration of particles administered by intratracheal insufflation. Arch. Ind. Hyg. and Occupational Med. 10:124-9, 1954.

Radioactive $BaSO_4$ particles (mean size-$1.45\mu \pm 0.4\mu$) suspended in H_2O were administered intratracheally to 90 CFW female rats in order to study the pulmonary penetration and distribution of the particles. Each rat received 25.7γ of $BaSO_4$ tagged with 35 μc. S. Groups of 5 rats each were serially killed at a specific time interval up to 8 da. after exposure, and the lungs, including the trachea, were removed, digested and assayed. Autoradiographs were made of lung sections from separate animals killed at corresponding intervals of time. These showed that, although the particles were generally distributed in the lobes of the lungs, the distribution was not uniform, but in irregularly shaped areas. Initial alveolar penetration and a rapid decrease in particle density over the 8-day time interval was observed. Elimination of the dust particles is thought to be effected by direct transport up the ciliated epithelium during the 1st 6 hr., and then by phagocytosis from the alveolar sacs. Retention data showed that about 40% of the material inside the syringe actually was deposited in the deep respiratory tract. The method of intratracheal insufflation directly through the pharynx may therefore be considered useful for the investigation of particulates in the lungs. Photos of autoradiographs of sections taken from different areas of lungs at time intervals of 10 min., 48 hr. and 192 hr. after insufflation are included.

700. Essenberg, J.M.: Effect of cigarette smoke on lung tumors of laboratory animals. Correspondence, J. Am. Med. Assoc. 156:909, 1954.

The author describes his experiment on production of lung cancer from smoking in C 57 mice, which ended in the death of all 40 mice from pneumonia before any significant tumor production occurred. It is, therefore, doubtful if Mouse C 57 can be used for lung cancer experiments. He further states that the dosage of smoke or the nicotine solution and the time of exposure are the most important points of such experiments, and the accepted method of procedure, which is briefly outlined, must be followed closely.

701. Gray, E.LeB., Patton, F.M., Goldberg, S.B. and Kaplan, E.: Toxicity of the oxides of nitrogen.II. Acute inhalation of nitrogen dioxide, red fuming nitric acid, and white fuming nitric acid. Arch. Ind. Hyg. and Occupational Med. 10:418-22, 1954.

Male albino rats were exposed in groups of 10 to the NO_2 and red fuming nitric acid (RFNA) vapors, and in groups of 5 to the white fuming nitric acid (WFNA) vapors (for which a smaller exposure chamber was used). LC_{50} for NO_2 exposure ranged from 1,445 - 88 ppm for exposure times ranging from 2 - 240 min.; for RFNA, LC_{50} was 138 and 67 ppm for 30 and 240 min. and for WFNA, LC_{50} was 244 ppm for 30 min. These data indicate that the primary toxic constituent of the acids is NO_2; under conditions of the experiments, the acid vapors added a small, and probably insignificant, toxicity to the NO_2 vapors. A rise in the ambient temperature of about 20°F. increased the toxicity of NO_2 to male rats by about 25%. Data obtained in the study suggest that there may be an appreciable strain variation in rats in response to the toxic action of NO_2. Death in all cases appeared to be due to pulmonary edema.

702. Gray, E.LeB., Goldberg, S.B. and Patton, F.M.: Toxicity of the oxides of nitrogen.III. Effect of chronic exposure to low concentrations of vapors from red fuming nitric acid. Arch. Ind. Hyg. and Occupational Med. 10:423-5, 1954.

Male rats (in 2 groups of 40 and 50), mice (30) and guinea pigs (10) were exposed 4 hr. daily 5 da./wk. for 6 mo. to red fuming nitric acid in concentrations that averaged approximately 4 ppm; the animals exhibited no toxic effects. Approximately 2 animals from each group were autopsied monthly, together with controls, and all animals remaining at the end of the experiment were autopsied. There was no evidence of pathology attributable to the exposure of these animals to the vapors of RFNA. Because of this, and because of work previously reported (Gray, E.LeB., MacNamee, J.K. and Goldberg, S.B.: Arch. Ind. Hyg. and Occupational Med. 6:20-1, 1952.) which showed that 9 and 14 ppm of NO_2 produced lung pathology under similar experimental conditions, it is felt that the MAC of the oxides of N should be set at 5 ppm.

703. Gross, P. and Westrick, M.: The permeability of lung parenchyma to particulate matter. Am. J. Pathol. 30:195-213, 1954.

The lungs with trachea from each freshly killed rat were suspended in a small glass jar and were caused alternately to "inhale" and "exhale" C-dust-charged air. The experimental details are described minutely. The average C particle size was 0.14μ. These "respirations" were continued from several min. to several hr. in different sets of lungs under different pressures after which the lung sections were histologically studied. In vivo experiments were also made in which India ink was diluted with equal parts of saline solution and injected intratracheally into rats in 1 ml. doses. Particle size was estimated at ca. 0.2μ. The rats were

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killed 4 hr. to 4 da. later. The macroscopic appearances of the lungs in both experiments are described in great detail. These experiments demonstrate that particulate matter per se may penetrate the respiratory membrane and migrate to perivascular and peribronchial positions without the mediation of phagocytic cells. Penetration of the respiratory membrane evidently occurs in multiple, small, scattered foci near the apposition to alveoli and larger vessels and bronchi. Although not demonstrated, it is nevertheless probable that the penetration of the respiratory membrane by particulate matter is dependent upon defects in the membrane, possibly in the form of erosions. Direct penetration of the alveolar lining by sufficiently fine particles is also a possibility. Important physical factors which make penetration of the respiratory membrane and the migration of particles possible are the fluctuating pressures of the respiratory cycle and the respiratory excursions of the lung tissue. On the basis of present experimental observations it would appear that most interstitial pneumoconiotic pigment deposits are probably extracellular agglomerations of particles. Assertions that pigment had been carried to its interstitial pulmonary position by macrophages are conjectural and are based upon a theory which is physiologically unsound. The experimental support of this theory is founded upon a premise which is unacceptable in the light of our present knowledge. More convincing supportive data should be required for the continued acceptance of the theory of the "emigrating-immigrating" or "returning" macrophage. (Based on author's summary.) (Note: "A good article. The author has made his point. The identity of position of extracellular aggregates in successive serial sections appears to rule out the possibility of these being artefactual." MLT)

704. Gurinov, B.P., Mashbits, F.D. and Shabad, L.M.: (Blastomogenic action of some tars formed from atmospheric dust and in combustion of various forms of fuel.) Gigiena i Sanit. 1954, No. 10:12-6.

In experiments extending over periods of up to 13 mo., mice, 2-3 mo. old, received, 3 times/wk., applications of 10% solutions of tars in benzol on the skin of the back, the treatment being continued until death occurred.

Results: The number of malignant tumors produced by the smear treatment corresponded satisfactorily with the content of 3:4-benzopyrene (B) in the tars applied. Tars from smoke soot ranging from 0.001 to 0.01% B produced an average of 37.5% incidence of tumors, while tars from atmospheric dust with 0.001 (figure given in table, in text: 0.002) - 0.005% B caused an average incidence of only 7.7%.

In each experimental group of mice, a further breakdown of the information obtained shows a parallelism of the B concentrations of the tars with the incidence of tumors resulting from the exposures. At 0.01% B, it was nearly 47%, at 0.005% B, it was 20% and at 0.001-0.003% B, it was 9.5%.

Tars from combustion of petroleum products ranged from 0.001 to >0.01% B content, among the lowest being that formed from the deposits on exhausts of diesel motors. High B contents were found in tars from combustion of peat (<0.01%), hard coal (>0.01%) and wood (>0.01%). The latter proved most active with regard to blastomogenic action, even though the onset of the physiologic changes follows a latent period of considerable length and therefore cannot be demonstrated in experiments of short duration.

From the experimental results, the author concludes that city air contains carcinogenic substances, e.g., B.

705. Haagen-Smit, A.J. and Fox, M.M.: Photochemical ozone formation with hydrocarbons and automobile exhaust. Air Repair 4:105-8, 136, 1954.

Concentrations varying from 0.1-10,000 ppm 3-methylheptane were systematically combined with concentrations of 0.1-100 ppm NO_2 and artifically irradiated with blue light for 10 hr. The amount of O_3 formed was measured during irradiation by the cracking observed on bent rubber strips (1.0 mm. crack about= 3 ppm O_3). The results of these experiments, graphed logarithmically, show a high and low concentration of NO_2 for each hydrocarbon concentration at which cracking will take place. Similar experiments were carried out with n-butane, n-pentane, n-hexane, n-heptane, n-octane, n-nonane and hexene-1, each at 3 ppm concentration, and similar results were obtained with optimum O_3 formation at 1-3 ppm NO_2. The O_3 formation capacity increases as the C chain increases for the straight chain paraffins C_4-C_9, with CH_4 and C_2H_6 inactive. A similar curve was also obtained from the sunlight irradiation of 3 ppm 3-methylheptane and variable NO_2 concentrations for 3 hr. in an atmosphere of synthetic air (80% N_2 and 20% O_2).

Experiments in which the amount of O_3 present was measured at the end of 4, 5, 10, 20, 24 and 30 hrs.' artificial irradiation showed the O_3 concentration to be nearly constant for about 20 hrs., i.e.,5-25 hrs. after irradiation. This O_3 concentration represented the excess O_3 from the different rates of formation and destruction of O_3. In sunlight and air 3 ppm 3-methylheptane and 1 ppm NO_2 gave a maximum 1.6 ppm O_3 in 3 hr., and 3 ppm and 0.4 ppm, respectively, gave a maximum 1.2 ppm O_3 after 5 hr. These hydrocarbon and NO_2 concentrations correspond closely to values actually found in the analysis of Los Angeles smog.

Sunlight irradiation experiments on automobile exhaust gases were also carried out. Exhausts from cruising and acceleration had to be diluted ca. 1/200th - 1/500th with air to obtain a hydrocarbon - NO_2 mixture which fell within the area of O_3 formation. NO_2 was added to exhausts from idling and deceleration to obtain the correct mixture. Thus, the O_3 generating capacity of automobile exhaust gases was demonstrated and, therefore, the gases are considered a definite source of smog.

706. Kotin, P., Falk, H.L., Mader, P. and Thomas, M.: Aromatic hydrocarbons. I. Presence in the Los Angeles atmosphere and the carcinogenicity of atmospheric extracts. Arch. Ind. Hyg. and Occupational Med. 9:153-63,1954.

Two large samples of the atmosphere were collected, one in a highly industrialized area during the smoggy season, the other adjacent to an area of high traffic concentration during the nonsmoggy season. After extraction from the filter paper the constituents of the sample were separated by column chromatography. Qualitative analysis identified chrysene, pyrene, 1:2-benzpyrene, 3:4-benzpyrene, 1:12-benzperylene and Compound Y (absorption spectrum illustrated) in both air samples. Compound X, anthanthrene and coronene, known to be in extracts of gasoline- and diesel-engine exhausts and incinerator smoke, could not be identified in the air samples. Quantitative analysis gave, in samples 1 and 2 respectively, in mg./1,000,000 ft.^{3}: pyrene-0.14 and C.32; 3:4-benzpyrene-0.92 and 0.84; in 1:12-benzperylene-1.00 and 0.35.

76 3-mo. old C57 black mice, fed a standard laboratory diet and water ad libitum, were painted 3 times weekly in the interscapular area with a benzene solution of the extracts of natural smog. Epilation occurred early, and in the mice dying at the beginning as a result of toxicity or intercurrent infection, cutaneous atrophy was noted. The 1st tumor appeared 15 mo. and 3 da. after the initiation of painting, at which time 31 mice were still living. Tumors developed on 12 more mice. The

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tumors all began as papillomas, primarily in the painted area, with a scattering of tumors behind the ear and laterally over the dorsum of the thoracolumbar region. Gross and microscopic findings are given with several photomicrographs. 69 C57 black mice were used as controls (painted with benzene), and 37 were alive at the time the 1st tumor appeared in the test animals. No skin tumors were seen in the control mice.

In the concluding discussion, the presence of aliphatic hydrocarbons and their oxidation products in the atmosphere is considered significant in the pathogenesis of lung cancer, first, by providing an eluent for the separation of adsorbed carcinogenic hydrocarbons from soot particles in the air, and 2nd, by the formation of various chemical compounds from unsaturated hydrocarbons, including theoretically the formation of diepoxides whose experimental carcinogenicity has been reported.

707. Kotin, P., Falk, H.L. and Thomas, M.: Aromatic hydrocarbons. II. Presence in the particulate phase of gasoline-engine exhausts and the carcinogenicity of exhaust extracts. Arch. Ind. Hyg. and Occupational Med. 9:164-77, 1954.

125 sample collection experiments were carried out on a blocked Ford V-8 gasoline engine. The aromatic hydrocarbons present with the exhausted engine soot were extracted with benzene and separated by column chromatography. The fractions were analyzed spectrophotometrically, but due to various experimental limitations, only semiquantitative data were obtained. Spectra of pyrene, 3:4-benzpyrene, 1:3-benzpyrene, 1:12-benzperylene, anthanthrene, coronene and Compound X were observed, but coronene was not estimated quantitatively. The gasoline engine was run under various conditions (variables - rpm, engine load, change of speed) to simulate and evaluate soot production under city traffic conditions. As the speed of the engine (rpm) increased, the quantity of hydrocarbons emitted decreased from a maximum; for pyrene this occurred at 1,500 rpm, for Compound X at 1000 rpm and for the other 4 at 500 rpm. The production of hydrocarbons decreased rapidly to near 0 as load increased. Largest production of all hydrocarbons occurred during acceleration and deceleration between 1000-1500 rpm. The greatest increase in production was primarily noted during acceleration. Pyrene was present in the largest amount in all samples, except on acceleration and deceleration between 2500-3500 rpm when it is virtually absent. The amounts of Compound X, benzperylene, anthanthrene and benzpyrene followed in decreasing order. Since the determinations were made on a stationary engine, extrapolation to traffic conditions was effected by $\mathrm{mph}=\frac{\mathrm{rpm X tire\ dimension}}{\mathrm{axle\ ratio}}$ and the resulting data tabulated.

108 C57 black mice were painted with thiophene-free benzene extracts of the engine exhaust samples. The 1st tumor appeared in 13 mo. and 25 da. after initiation of painting at which time 86 mice were still alive. 38 tumor-bearing mice with carcinomas on 22 of them had thus far been demonstrated. The tumors all began as papillomas except in 2 instances of primary development of a carcinoma. In general, the gross and histopathologic appearances of the papillomas were similar to those reported previously (Ibid. 9:153-63, 1954). However, more than 60% of the tumor-bearing animals bore multiple tumors; 2 mice had 5 individual papillomas and 3 had 4 apiece. 69 C57 black mice were used as benzene controls. 42 were alive at the time of the 1st tumor appearance in the test animals, and exhibited no skin tumor.

In conclusion, it was found that in driving through all types of metropolitan areas in both peak and nonpeak traffic 18% of the time the engine was idling; 18%, decelerating; 18%, accelerating and 46%, cruising. The amount of polycyclic hydrocarbons and soot emitted was maximal on

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acceleration and idling, but the amount of uncombusted gasoline emitted was maximal on deceleration, then idling and minimal on cruising and acceleration. If benzpyrene requires the presence of soot, hydrocarbon aerosols and hydrocarbon oxidation products to be effectively carcinogenic, idling gives exhausts in their worst form, then acceleration, deceleration and cruising the least.

708. Sampey, J.R.: Hydrocarbons as anticancer agents. Ind. Med. Surg. 23:159-60, 1954.

The use of some polycyclic hydrocarbons as anticancer agents is briefly reviewed. 1:2:5:6-dibenzofluorene, some benzanthracene derivatives, e.g., 1:2-benzanthracene, 8-methyl-1:2-benzanthracene, 10-methyl-1:2-benzanthracene and methylcholanthrene, dibenzanthracene, benzopyrene and benzanthracene in near lethal doses are effective in rats and mice as anticancer agents. Mixtures of strong skin carcinogens exert an inhibitory action in skin cancer on each other apparently. Various methods of administration were used: subcutaneous injection, painting of the skin, intraperitoneal and intravaginal injection and ingestion. No inhalation studies are mentioned. 18 references are included.

709. Steiner, P.: The conditional biological activity of the carcinogens in carbon blacks and its elimination. Cancer Research 14:103-10, 1954.

The following materials were injected subcutaneously into each of 50 mice: (1) 300 mg. 3:4-benzpyrene (bzp)-containing C black, (2) 1.0 cc. tricaprylin, (3) 300 mg. pellets, bzp-containing C black, (4) 300 mg. nonbenzpyrene (nbzp)-extractable C black, (5) 300 mg. pellets, nbzp-extractable C black, (6) 300 mg. nbzp-extractable C black with 0.09 mg. bzp added, (7) 0.09 mg. bzp/1 cc. tricaprylin, (8) 300 mg. pellets, nbzp-extractable C black with bzp added, (9) 300 mg. benzene extract of bzp-containing C black, (10) 300 mg. C black residue after benzene extraction, (11) 300 mg. bzp-containing C black treated with chromic acid and (12) mixture of 300 mg. bzp-containing and 300 mg. nbzp-extractable blacks. The 1st, 7th and 9th injections induced 18, 39 and 22 sarcomas, respectively, and the tumor yield was 39.1, 95.1 and 48.9%, respectively. The following conclusions were reached. "A C black from which 3:4-benzpyrene and other aromatic hydrocarbons could be eluted with benzene was carcinogenic on subcutaneous test in mice when it was injected with tricaprylin but practically inactive in pellet form. This difference in result is interpreted as showing that the subcutaneous tissues had no eluent adequate to make the chemical available for carcinogenic action on the adjacent cells." "A C black whose benzene extracts contain no recognized carcinogenic hydrocarbons was slightly carcinogenic on biological test. It is probable that adsorbed carcinogenic chemicals were present which were not eluted in vitro but which became available for carcinogenic activity in vivo, indicating that the biological test for carcinogenicity was better than the chemical. When the potent carcinogenic aromatic hydrocarbon, 3:4-benzpyrene, in an amount which when tested alone gave a 95% tumor yield, was added to a noncarcinogenic C black of small average particle diameter prior to injection, no tumors were induced by the combination. This inactivation is attributed to adsorption, and it is interpreted as signifying that in the adsorbed state this carcinogen was rendered biologically inactive. The carcinogenic activity of a C black was eliminated by destruction and by adsorption; it was nearly eliminated by solvent extraction. The phenomenon of adsorption was a more potent factor than the solvent in determining the carcinogenic response

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under the experimental conditions used. The principles of natural and conditional carcinogens, of solvent elution and of adsorption are advanced to explain some clinical and epidemiological observations on human skin and lung cancers, and on the role of preceding pathological lesions in predisposing to pulmonary tumors."

710. Urban, E.C.J.: Two chambers for use in exposing laboratory animals to the inhalation of aerosols. Arch. Ind. Hyg. and Occupational Med. 9:62-8, 1954.

The details of construction and operation of 2 types of chambers used for the exposure of numbers of laboratory animals to the inhalation of dust and aerosols have been outlined. In their design, important consideration was given to protecting the operating personnel from exposure to the toxic materials which were studied.

711. Clemo, G.R., Miller, E.W. and Pybus, F.C.: Carcinogenic action of city smoke. Brit. J. Cancer 9:137-41, 1955.

Fractions A, B and C obtained from city smoke as described by Clemo (Chemistry & Industry 1953:957-64.) were each diluted to a 1.0% solution in C_6H_6 and painted in the interscapular region of mice 3 times/wk. until death or until definite malignant tumors appeared. Two fractions from diesel engine fumes were similarly applied. The 83 treated mice (M & F) belonged to several inbred strains, viz., CBA/Mr, A/Gr_f, C57BL/How, C57BL/Gr, GFF, GFF_f, A2G and $C3H_f$. 21 control mice from these strains were painted with C_6H_6 only. Microscopic examinations were made of sections of all skin papillomata and epitheliomata. The details of the results are tabulated. Fractions B and C showed carcinogenic action on mouse skin and it is suggested that there must be at least 2 different chemicals. Fraction B produced papillomata in 4 and epitheliomata in 3 out of 4 C57BL/Gr mice, and papillomata in 5 and epitheliomata in 2 out of 6 A/Gr_f mice after 8-13.5 mo. of painting. Fraction C produced 5 papillomata and 6 epitheliomata in C57BL/How mice with a rapidly growing epithelioma appearing after 6 mo. in 1 case. 4 of the 5 A/Gr mice treated with B had multiple lung nodules and 1 had a large stomach papilloma. Fraction B also produced 3 lung nodules in 1 CBA mouse, an unusually large number for a mouse of this strain 18 mo. old, and a small lung carcinoma in 1 out of 4 C57BL/Gr mice, a strain highly resistant to lung tumors. Strain A is noted for its high susceptibility to induced lung tumors; the number of lung nodules produced in individual mice has long been used as a criterion of the potency of a carcinogen. 4 lung nodules were found in an A2G mouse painted for 8 mo. with the 1st diesel fraction; all the other mice in this group and in the group painted with the 2nd diesel fraction gave negative results. The results, however, are inconclusive on account of the age of the mice. Results obtained with fraction A were also inconclusive. The C57BL mice seemed to be more susceptible than A strain mice to the induction of skin tumors, the skin reactions in the C57BL mice painted with fraction B being much more extensive than in the A/Gr_f mice. Besides strain specificity there is also the question of tissue susceptibility. These experiments were concerned not with pure chemical substances but with a mixture of as yet unidentified chemicals and it may well be that more than one carcinogen was present, one specific for skin, another for the lungs, and that one strain of mouse may be more susceptible to one carcinogen than to another. This question is discussed in relation to the controls painted with C_6H_6 alone, none of whom developed skin growths, but one was found to have lung nodules.

712. Clemo, G.R. and Miller, E.W.: The carcinogenic action of city smoke. Chemistry & Industry 1955:38.

In the Presidential Address to Section "B" of the British Association at Liverpool in 1953 (Ibid. 1953:957-64), a brief account was given of the isolation of 3 fractions A, B and C (each a mixture) from city smoke. These were tested for carcinogenic action as well as 2 fractions isolated similarly from diesel bus smoke. Fractions B and C produced tumors in 12 of the 29 effective mice treated. The earliest tumor appeared after 6 mo. but the average period was 9 mo. Under similar conditions pure benzpyrene is recorded as producing tumors in from 4-6 mo. in 50% of the mice treated. Further, 13 of the mice showed skin papilloma and 5 of them lung nodules (3, 4, 3, 3 and 1 nodules, respectively). Fraction A produced some lung nodules but otherwise has not shown the activity of B and C. The diesel fractions, on the other hand, have so far given negative results apart from 1 mouse developing lung nodules. The conclusion is clear that city smoke has a marked carcinogenic action. A full account of the tests will be published elsewhere and the work is being continued. (Complete article.)

713. Diggle, W.M. and Gage, J.C.: The toxicity of ozone in the presence of oxides of nitrogen. Brit. J. Ind. Med. 12:60-4, 1955.

A series of rats (3-4 in a group) and mice (5-7 in a group) were exposed for a 4-hr. period to increasing concentrations of O_3. As the dosage increased from 3.4-36 ppm, the symptoms grew worse from respiratory distress to dyspnea to death during exposure. LD_{50} was 10-12 ppm. Postmortem examination revealed the lungs distended with edematous fluid. Histologically, edema and emphysema, but no hemorrhage, were noted. 6 male rats exposed to 2.5 ppm O_3 for 4 hr./day for 8 da. suffered no apparent discomfort and gained weight normally. Histological examination revealed nothing abnormal. Similarly, 5 male rats were exposed to 4.5 ppm O_3 for 19 da. All survived except one (probably died of pneumonic infection) and increased in weight normally, though they showed slight distress towards end of each 4-hr. period from which they recovered overnight. Histological examination showed small edematous patches. 36 rats, 3 at a time, were exposed to various mixtures of O_3 and NO_2 and to the resulting N_2O_5. Analyses of the amounts of O_3 and NO_2 used up and the quantity of N_2O_5 produced in the exposure chamber are in accord with $2NO_2 + O_3 = N_2O_5 + O_3$. The results of these analyses are tabulated. Since N_2O_5 is about 3 times as active as O_3, the total equivalent O_3 concentration was calculated as = O_3 concentration + 3 x N_2O_5 concentration; this quantity ranged from 5.9-12.0 ppm. Calculated on this basis the LD_{50} is of the same order of magnitude as for O_3 alone. At the lower concentrations the rats showed mild respiratory distress; increasing concentrations produced coma, acute gasping dyspnea and finally death during exposure or delayed. All the data (concentration, number of animals, sex, mean weight and effects) are tabulated. Histological examination of the lungs of affected animals revealed edema and emphysema and some congestion of the alveolar capillaries, but no hemorrhage.

In the discussion it is noted that ozonization by spark discharge produces large enough quantities of NO_2 along with the O_3 to produce appreciable amounts of N_2O_5 and possible toxic effects. This does not occur with a silent electrical discharge.

714. Kotin, P. and Falk, H.L.: Air pollution and its effect on health. Calif. Med. 82:19-24, 1955.

A brief discussion of previous smog episodes is given. What must be considered in planning a study of the effects of smog on health and the 3

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clinical types of host response to air pollution, viz., acute, subacute and chronic, are discussed. In the experimental studies, an atmosphere of 4 ppm total oxidant (ca. 10 X the naturally occurring amount on smoggy days) was chosen; this was increased to 3,000 ppm when neither in vivo or in vitro changes could be demonstrated at 4 ppm. 21 amino acids were exposed to 4 ppm oxidant for 17 hr.; 8 of them (histidine, methionine, tyrosin, tryptophane, lysine, leucine, proline, cystein and glutathione) were found altered. Exposed vitamins produced variable results; thiamin and pyridoxine were altered by 3-min. exposure to 4 ppm oxidant, while folic acid, carotene and α-tocopherol were altered only when exposed to 3,000 ppm oxidant at which concentration riboflavin and niacine were still unaltered. Cholesterol was oxidized with 4 ppm smog for 3 min. Androgenic, progestational and adrenocortical hormones were destroyed with 3-min. exposure of 4 ppm oxidant, but estrogenic hormones withstood all concentrations of smog. In the purine and pyrimidine group, xanthine and uracil were altered only by 3,000 ppm. In the porphyrin group, cytochrome-C and hemoglobin were altered significantly. These results were checked immediately in Wistar white rats which were exposed to 4 ppm oxidant from 10-180 min.; hemoglobin oxidation to methemoglobin varied 0.5-10%. At 3,000 ppm oxidant the rats died in 10 min.; 25% methemoglobin was found and plasma proteins were altered. Effects of N oxides on the lung and of smog containing 3,000 ppm oxidant on the trachea and lung are shown. It is only at 10,000 times the concentration of pollutants in Los Angeles that acute morphological changes have been significant.

715. Kotin, P., Falk, H.L. and Thomas, M.: Aromatic hydrocarbons. III. Presence in the particulate phase of diesel-engine exhausts and the carcinogenicity of exhaust extracts. Arch. Ind. Health 11:113-20, 1955.

60 1-min. samples of the exhaust from a blocked diesel engine were collected. A warmed-up diesel engine with properly adjusted fuel feed produces little smoke and consequently only traces of aromatic polycyclic hydrocarbons. At 1200 rpm, with loads varying from 0-full, pyrene concentration varied from 8-16 γ (µg./min.), 1:12-benzperylene from 0.4-8γ and anthanthrene from 0.3-1.5γ. The production dropped during 5 consecutive alternating periods of acceleration and deceleration, lasting 1 min. under varying loads. An inefficiently operating diesel engine, or an efficient one that is warming up, emits a great deal of black soot with significant amounts of polycyclic aromatic hydrocarbons. Production of pyrene, benzpyrene, benzperylene, anthanthrene and Compound X did not vary uniformly at fixed speeds, increased markedly as load increased, and increased enormously during acceleration. This is in contrast to the gasoline engine. At 1000, 1200 and 1400 rpm, the highest concentration with increased load was 2500γ pyrene, and on acceleration was 5000γ pyrene. 3:4-Benzpyrene, 1:12-benzperylene, anthanthrene and Compound X followed in order of decreasing concentration.

52 C57 black mice, male and female, were painted 3 times/wk. in the interscapular area with extracts of the exhausted particulate phase from a diesel engine running at 0 load during its warm-up stage. 50 A strain male mice were painted in the same manner with extracts of the exhausted particulate phase from a warmed-up, inefficient engine running at full load. The C57 mice underwent a severe systemic reaction to the material after each painting but returned to normal before the next painting. 16 deaths ensued approximately 10 wk. after initiation of the painting. Necropsy examination and histopathological studies indicated a combined hepatotoxic and nephrotoxic effect, with acute pneumonia diagnosed as the immediate

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Kotin, P. et al. (continued)
cause of death. Thereupon, the painting sample was repeatedly diluted until a tolerable dose was reached. The 1st tumor appeared in 13 mo., followed by only 1 additional neoplasm. With the A strain mice, approximately 16 mo. after initiation of painting, the 1st tumor appeared followed by 3 more tumors; 3 of the 4 tumors were carcinomas. A 2nd experiment with 50 A strain male mice was begun 3 mo. after the 1st, but the mice did not show the same resistance to the toxic effects as in the first experiment. After experimentation with several strains of mice, 25 A strain female mice were painted with extract of the exhausted particulate matter obtained during full load. The 1st tumor appeared in approximately 13 mo., indicating the presence of a carcinogen of considerable potency in the exhaust extracts, and 16 more tumors appeared in the next 4 mo. 11 of these were carcinomas. 69 C57 black mice and 34 A strain mice were used as controls, on which no skin tumors were observed.

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716. Kotin, P. and Falk, H.L.: Production of tumors in C57BL mice with atmosphere-extracted aliphatic hydrocarbons. Proc. Am. Assoc. Cancer Research 2, No. 1:30 (Abst.) 1955.

Previous studies have been presented reporting the quantitative presence of aromatic polycyclic hydrocarbons including 3:4-benzpyrene in vehicular exhaust products and in urban atmosphere. Acetone extracts of these traditional experimental carcinogenic compounds have produced skin cancers in C57BL mice. In addition, a nonaromatic hydrocarbon fraction has been collected, acetone extracts of which have been used to produce skin tumors in mice. Approximately 15%, or 5 of 35 mice painted, developed skin tumors. The 1st tumor appeared 14 mo. following paintings 3 times/wk. Four papillomas and one cancer were observed. This fraction consisted of aliphatic hydrocarbon compounds which on UV spectrophotometric analysis failed to show the presence of contaminating aromatic substances.

Chemically, the aliphatic materials in this fraction consisted of the oxidation products of gasoline produced by oxidation in inhalation chambers with O_3 and light energy. These products of branched and cyclic hydrocarbons may be assumed to include epoxide states similar to those used by the British for tumorigenesis in rats. Their significance in human pulmonary carcinogenesis resides in that their introduction into the environment parallels the use of internal combustion engines, and their physical state precludes the necessity for postulating an eluting agent in the tracheobronchial tree.

Injection and inhalation experiments are now in progress. Control diepoxide material has been obtained from the Chester Beatty Research Institute. The inhalation experiments are being conducted in an aliphatic aerosol atmospheric environment.

The tumorigenic agent present may be presumed to be of a low order of potency.

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717. LaBelle, C.W., Long, J.E. and Christofano, E.E.: Synergistic effects of aerosols. Particulates as carriers of toxic vapors. Arch. Ind. Health 11:297-304, 1955.

In each experiment, 2 or more successive groups of 6 white mice were exposed to formaldehyde, acrolein or HNO_3 fumes plus various aerosols in a chamber until all were dead, the time at which each individual mouse died being recorded. The geometric mean time of survival ($S.T._{50}$) and its corresponding geometric standard error were calculated. Concentrations of the vapors were used which led to a suitable $S.T._{50}$. As a check, groups of 6 mice each were killed after 20-min. exposure to the same

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LaBelle, C.W. et al. (continued)
mixtures. The lungs were removed, weighed and the body-weight:lung-weight ratio calculated. Increases in the relative weight of the lungs were assumed to reflect accumulation of edema fluid in lungs damaged by irritation. The various aerosols used were triethylene glycol, ethylene glycol, mineral oil, glycerin, NaCl, dicalite, celite, attapulgus clay and santocel CF; they were inert with respect to irritant action in the lungs. Their concentrations ranged from 0.31-2.21 mg./l. with CHOH and 0.05-0.38 mg./l. with acrolein and HNO_3 fumes; the mass median size of the aerosols ranged 1.8-3.3 μ. It was found that when aerosols were added to atmospheres containing CHOH vapors, the typical effect is to increase the toxicity. Aerosols added to HNO_3 fumes tend to decrease the toxicity, while the addition of aerosols to acrolein vapors has a variable or no effect on toxicity. The penetration of gases through the nose ranges from a fraction of 1% for a gas like HCl to 100% for N_2. The penetration of aerosols ranges from about 20% for 5μ particles to 100% for 1μ particles. The effect of aerosols in altering the toxicity of irritant gases is closely and directly related to the relative penetration of particles and vapor molecules present. When the aerosol penetration exceeds vapor penetration, toxicity is increased; when vapor penetration exceeds particle penetration, toxicity is decreased. These are necessary but not sufficient conditions; there must be a physical combination between vapor and aerosol (absorption, adsorption, solution), or no change will occur at all. The penetrating powers of the aerosols and the vapors are compared and from this the behaviors of mixtures with respect to increasing or decreasing the $S.T._{50}$ are predicted; these are compared with the observed behaviors. 19 predictions out of 27 were correct.

718. Byers, D.H. and Saltzman, B.E.: Toxicity studies of nitrogen dioxide-ozone mixtures and nitrogen pentoxide. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 10B.

Of frequent appearance in the literature is the assertion that the apparent toxicity of O_3 is due to oxides of N present as impurities. Corollary to an extensive study of O_3 toxicity, a study of the toxicity of NO_2-O_3 mixtures was undertaken. N_2O is known to be of little toxicological significance. NO_2 and N_2O_3 are immediately oxidized by O_3. N_2O_4 is completely dissociated at the low concentrations considered. NO_3 and O_3 were mixed in various proportions and white mice were exposed to the diluted mixtures. No significant changes in the toxic effects of O_3 alone were observed. When mixed at concentrations of the order of 500 ppm by volume, O_3 and NO_2 reacted rapidly and almost stoichiometrically in the ratio 1 to 2. The product, presumed to be N_2O_5, caused no fatalities in white mice exposed for 4 hr. to concentrations as high as 35 ppm by volume (N_2O_5), compared to an LD_{50} of 6 ppm of O_3 for 4-hr. exposure. HNO_3 vapor at 500 ppm was likewise without fatal effect.

719. Cohn, S.H., Lane, W.B., Sherwin, J.C. and Gong, J.K.: Air-borne simulants of fall-out from nuclear detonation-preparation and biological application. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 4B.

Among the many air pollution problems, one of the most recent and potentially most hazardous is that presented by radioactive fall-out. In order to assess the inhalation hazard, mice were exposed to air-borne simulants of fall-out resulting from nuclear detonation. Since the metabolism, and consequently the hazard of inhaled fission products associated with fall-out, depend to a great extent on the type of carrier material used, a

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Cohn, S.H. et al. (continued)
variety of simulants was developed and studied. This report describes the preparation of these fall-out simulants and presents the results of their biological application. The method of aerosol preparation and generation, the physical and chemical characterization of the aerosols and the uptake, distribution and retention of these simulants in the exposed animals are presented.

720. Cohn, S.H., Lane, W.B., Gong, J.K., Sherwin, J.C. and Milne, W.L.: Inhalation and retention of simulated radioactive fall-out by mice. I. Study of a simulant of fall-out from nuclear detonation under sea water. Arch. Ind. Health 14:333-40, 1956.

The uptake, distribution and retention of fission products in mice were investigated as follows. 48 mice were exposed for 1 hr. to an aerosol (mean size-1.8μ, maximum-3.7μ) of fall-out simulant containing the ionic form of a 65-hr. fission-product mixture prepared by neutron irradiation of U. The mice were then placed in metabolism cages for collection of excreta. They were killed in groups of 6 at 1 hr., 3 hr. and 1, 4, 7, 14 and 28 da. following exposure and their tissues measured for γ-activity. Another 30 mice, 10 in each of 3 chambers, were simultaneously exposed and then utilized for measurement of whole-body activity. Half of each group was exposed for 10 min. and the other half for 1 hr. All mice were washed to remove as much external activity as possible and then their activity was measured in a 4 pi gamma ionization chamber. This activity was determined daily until it dropped below the level of sensitivity of the instrument. In addition, 1 mouse from each group was killed right after exposure, the skin removed and its residual γ-activity determined. The level of whole-body activity resulting from acute exposure was found to be proportional to both the length of exposure and the concentration of air-borne activity. At 1 hr. after exposure the bulk of activity was found in the G.I. tract, lung and head, with smaller amounts in the skeletal system, liver and blood. A smaller, but still a significant, amount was present in the thyroid. The concentration in the G.I. tract was 3 times that found in the respiratory tract and lung at this time. At 1 mo. the residual activity in the skeleton was the highest of any tissue, followed by the lung and head. Barely detectable amounts of activity were present in the liver. At 2 mo. detectable activity was still present in the skeleton and lungs. The activity/g. tissue at 1 hr. following exposure was highest in the respiratory system and thyroid. The skeleton and liver contained the lowest. Although the G.I. tract contained the largest amount of activity at 1 hr., the total dose it received was the lowest of any of the tissues, due to the rapid biological loss of simulant material by excretion. The internally deposited activity is contributed chiefly by isotopes of short radiological and biological half-life. The longer-lived fission products are primarily "bone-seekers" and are deposited in the skeletal system. The radioactive decay of most of the activity in the soft tissues was very similar for the first 4 da. following exposure. The biological turnover varied considerably among the tissues studied. The fission-product material was lost most rapidly from the blood and G.I. tract and only very slowly from the skeletal system. The rate of elimination in the lungs lies between that of the other soft tissues and that of bone. The relatively short biological and radioactive half-life of the inhaled fission products minimizes the internal radiation hazard relative to the external hazard following an acute inhalation exposure to fall out.

721. Dalhamn, T. and Rhodin, J.: Mucous flow and ciliary activity in the trachea of rats exposed to pulmonary irritant gas. Brit. J. Ind. Med. 13:110-3, 1956.

The apparatus employed permits meticulous determination of the rates of mucous flow and ciliary beat. With this method the action of certain pulmonary irritant gases has been studied. The results of prolonged exposure to SO_2 are reported here. It has earlier been demonstrated (by Amdur, et al., 1953) that even low concentrations of this gas may give rise to several changes in the respiratory pattern. Functional and morphological changes occurred in 9 rats that had been exposed to 10 ppm or 10^{-3} volumes % SO_2 for 6 hr./day for ca. 10 wk. Thus the rate of mucous flow was considerably reduced and the amount of secretion greatly increased. The rate of ciliary beat, on the other hand, was unaffected. Nor did the phases of the ciliary beat appear to alter in character. The morphological reactions were mainly seen in the epithelium and lamina propria. The epithelial cells were long and slender with compressed nuclei. The surface facing into the tracheal lumen was very irregular and showed deep crypts. In the lamina propria there was severe edema with splitting and fragmentation of the collagen fibrils, profuse vascularization and blood escaping perivascularly. The electron microscopic studies reported here particularly concerned ciliary structure. This did not differ from the structure observed in healthy rats. It would thus seem that the functional changes noted are primarily attributable to alterations in the character of the mucosal secretion and not to injury to the ciliary mechanism as such. The results of the morphological studies confirmed these findings.

722. Gordieyeff, V.A.: Toxicity of vapors in the presence of aerosol carriers. Chem. Warfare Lab. Army Chemical Center, Md. CWLR-2053, Aug. 17, 1956, 70 pp.

This paper is the final part of 3 studies on the interaction mechanism between vapors and air-borne particles. It gives the results of toxicological experiments performed to test the Dautrebande hypothesis that vapor sorption on inert, air-borne, carrier aerosols possibly increases the toxicity of a vapor. The experimental setups (involving exposure chambers of the semistatic and the dynamic type) are described. Mortality curves for rats, mice and hamsters are compared for vapors of acetone, cyanohydrin, mustard gas, Sarin, phosgene and formaldehyde in the absence and presence of various carriers. The mortality data do not show any significant differences which could be ascribed to the synergistic action of the carriers. This result confirms the predictions based on the studied mechanism of sorption of vapors by various air-borne carriers. The validity of these results is limited to acute inhalation toxicities of volatile substances sorbed on biologically inert aerosols. (Nuclear Sci. Abst. 10:1172, 1956.)

723. Stokinger, H.E.: Hazard evaluation of ozone and oxides of nitrogen. Factors modifying toxicity. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956. p. 8B.

Experimental evidence is presented that O_3 in single, acute exposures is a highly poisonous substance and that, contrary to past assertions, no experimental evidence was found that this toxicity is modified to a significant degree by the presence of N oxides that may accompany O_3 production. LD_{50} values for single, 4-hr. exposures in mice, rats and hamsters ranged from 3.8 to 10.8 ppm O_3 by volume, corresponding to a total lethal dose of 4 γ for mice and 50 γ for rats. 7 factors, viz., age, physical exertion,

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Stokinger, H.E. (continued)
respiratory infection, alcohol, intermittent exposure, pre-exposure and premedication, have been found experimentally to modify the toxicity of O_3. Consideration is given these factors in evaluating possible hazards to populations of O_3-containing smogs.

724. Pace, D.M.: Tissue culture as a tool in the evaluation of air pollution. Abstracts of Papers, 130th Meeting of the American Chemical Society, Atlantic City, N.J., Sept. 16-21, 1956, p. 8B.

A study is under way to ascertain the effects of single as well as multiple constituents of polluted air on tissue cells cultured in vitro. Some of the more common pollutants are under investigation. Growth rates, lethal effects, respiratory metabolism and morphology are used, comparatively, as criteria for judging possible long range accumulative effects of low concentrations of the substances tested. SO_2 and NO_2, just like many other constituents of air, in high concentration have a noticeable effect on proteins in the culture media. For this reason, plain saline solutions are used as well as serum-embryo solutions. The number of cells existing at any particular time are enumerated by count as devised by Earle and his coworkers. Respiratory metabolism is ascertained by means of a Warburg Microrespirometer using modified flasks. The morphology of the cells is studied by way of lapse-time cinephotomicrography in which pictures are taken at various times during the over-all period of the experiment. Some of the results obtained by using these methods are presented.

725. Vocci, F.J., Krackow, E.H., Swann, H.E., Jr., Eipper, J.E. and Ballard, T.A.: An apparatus for quantative studies of inhaled aerosol by dosimetric procedure. J. Air Pollution Control Assoc. 6:69-71, 1956.

An apparatus for the determination of retained dose of aerosols in the respiratory tract of dogs is described. It consists of a dispersion chamber, a subchamber assembly and the physiological recording instruments. Use of this apparatus provides for the following: 1) dosimetric studies of inhaled aerosols and 2) correlation of air-borne aerosol (concentration and particle size distribution) with retained dose of inhaled aerosol and toxicological and pharmacological effects, e.g., respiratory, cardiovascular, neurological and muscular effects.

SEE ALSO: Ascher 4, 5; Jötten 43; Campbell 240; Kotin 344; Anon. 396; Brieger 400; Falk 401; Binz 418, 419; Ascher 421; Henderson 426; Jaensch 438; Gaisböck 444; Ranelletti 445; Roholm 460; Thorp 476; Von Oettingen 477; Davies 496; Bartak 517; Stokinger 527; Friberg 532; Sjöberg 546; Mellon Inst. 559; Greenwald 572; Stokinger 577; Kotin 585; Pattle 601.

V. CARDIOVASCULAR AND PULMONARY FUNCTION, AND OTHER TESTS

726. Cournand, A., Richards, D.W., Jr. and Darling, R.C.: Graphic tracings of respiration in study of pulmonary disease. Am. Rev. Tuberc. 40:487-516, 1939.

A simple technic is described whereby tracings of respiration can be recorded in normal and pathological subjects. The apparatus is a modification of the ordinary Benedict-Roth metabolism apparatus for graphic registration of breathing. The measurements used for recording respiration are: (a) quiet breathing, (b) deep (vital capacity) breathing, (c) maximum breathing capacity. Bronchodilator drugs may cause marked changes in amplitude and form of tracings. An additional measurement is the O_2 deficit (the excess O_2 absorbed when the subject breathes pure O_2, as compared with room air). This gives an index of O_2 want. The spirographic technic is of special usefulness in the study of obstructive emphysema. It may provide information of values in certain cases of cardiac disease, and in such conditions as chest deformities, respiratory neuroses and malingering. It frequently gives objective evidence to explain the nature of the patient's dyspnea. Spirograms also offer a convenient method of following quantitatively over a period of years a patient's pulmonary function. A number of illustrative cases of normal subjects and of those with the above types of pulmonary diseases are described.

727. Silverman, L., Lee, R.C. and Drinker, C.K.: A new method for studying breathing, with observations upon normal and abnormal subjects. J. Clin. Invest. 23:907-13, 1944.

A new pneumotachographic device is described (and diagramed) for making a graphic record of the velocity of air movement during inspiration and expiration. The inspiratory and the expiratory air currents cause the deflections of fine wires, which are recorded photographically by a moving paper camera. Typical illustrations of the resulting curves are presented, showing the results on 1 normal individual and on 5 patients with respiratory difficulties. The total min.-vol. and the instantaneous air flow can be obtained from the records made by the instrument.

728. Baldwin, E. deF., Cournand, A. and Richards, D.W., Jr.: Pulmonary insufficiency. III. A study of 122 cases of chronic pulmonary emphysema. Medicine 28: 201-37, 1949.

Various types of pulmonary dysfunction observed in 122 cases of chronic pulmonary emphysema are described and discussed. A physiological classification of chronic pulmonary emphysema is proposed, in which cases with pulmonary insufficiency and those with cardiopulmonary insufficiency are considered separately. The severity of pulmonary insufficiency was judged from the reduction of the arterial O_2 saturation and from the increase in CO_2 tension following a standard exercise test. Four groups were thus defined. In group 1 severe impairment of the ventilatory function and moderate disturbance of intrapulmonary air distribution are present. Hyperventilation, however, adequately compensates for the disturbance of distribution, thus maintaining an adequate alveolar ventilation with normal respiratory gas exchange and preventing the development of arterial anoxia. The major disability of this group, therefore, is the reduction in breathing reserve, which limits physical activity and causes dyspnea. In group 2 impairment of the ventilatory function and greater disturbance of air distribution appear. Although hyperventilation still maintains a relatively normal arterial CO_2 tension, the compensation is not sufficient to prevent arterial anoxia at rest and following exercise. To the reduction in breathing reserve another major disability is thus added in this group, viz., alveolorespiratory insuf-

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Baldwin, E. deF. et al. (continued)
ficiency. In group 3 the reduction of ventilatory function and the disturbance in air distribution are both marked. Compensatory hyperventilation during exercise and early recovery is not possible because of the limitation of the ventilatory capacity. This adds to the inadequacy of the alveolar ventilation as a cause of the arterial CO_2 retention and arterial anoxia. This group suffers from profound ventilatory and alveolorespiratory insufficiency. In group 4 a ventilatory and an alveolorespiratory insufficiency nearly as severe as in group 3 is associated with evidence of polycythemia and chronic, congestive heart failure. Hypoventilation during all the periods of observation in the presence of a high arterial CO_2 tension and acidosis, and a low O_2 saturation are striking features of this group. They reveal a profound disturbance in the response of the respiratory centers to normal stimuli. Individual cases, some of them with autopsy findings, have been described in order to illustrate further the characteristic pattern of pulmonary dysfunction observed during the course of the disease.

729. Bruce, R.A., Lovejoy, F.W., Jr., Brothers, G.B. and Velasquez, T.: Observations on the causes of dyspnea in chronic pulmonary granulomatosis in beryllium workers. Am. Rev. Tuberc. 59:364-90, 1949.

The resting and exercise measurements of pulmonary and cardiovascular functions in 6 patients with chronic pulmonary granulomatosis are presented in relation to the evolution of the functional impairment and its complications. The results of these studies are essentially in accord with those observed by other investigators of a similar group of patients. The main deviation from normal is the hyperventilation, especially during work, compensating for hypoxemia. Diminished arterial O_2 saturation is a function of abnormally increased alveolar-arterial gradient for O_2 and contracted lung volume, particularly complementary air. One of these patients exhibited polycythemia as a compensatory mechanism. Various stages of cor pulmonale, including congestive heart failure due to increased pulmonary resistance, were observed. An unusual response to intravenous digoxin and the lack of benefit from cytochrome C therapy are recorded. Variations in response to exercise and similarities to functional impairment of other pulmonary disease are discussed. (Authors' summary.)

730. Donald, K.W. and Christie, R.V.: A new method of clinical spirometry. Clin. Sci. 8:21-31, 1949.

A new and simple method of spirometry is described which enables volumetric respiratory tracings to be obtained while breathing any mixture of gases. The inertia, resistance and temperature changes in the circuit and technic of filling the spirometer are described. Some uses of the spirometer in clinical investigation are given. If no CO_2 absorbent is employed, the reaction to CO_2 and anoxia, changes in respiratory quotient, the vital capacity and abnormal respiratory behavior while breathing different gases can be studied. With an absorbent canister in the circuit, the O_2 uptake and ventilation can be determined while breathing air or any other percentage of O_2. The spirometer also records the absorption of soluble inactive gases. (Authors' summary.)

731. Riley, R.L.: The measurement of pulmonary function. Veterans Admin. Tech. Bull. TB 10-58:1-10, 1949.

The physiology of pulmonary function is discussed in general and under the separate aspects of over-all ventilation, over-all circulation, the distribution of inspired air and mixed venous blood to different parts of the lungs and diffusion with special emphasis on the tests available for its measurement.

732. Baldwin, E.deF., Harden, K.A., Greene, D.G., Cournand, A. and Richards, D.W.: Pulmonary insuffiency. IV. A study of 16 cases of large pulmonary air cysts or bullae. Medicine 29:169-94, 1950.

A physiological classification of large pulmonary air cysts or bullae is proposed, based on the study of 16 cases. Three groups are defined according to the state of the bronchial communication leading to the air cyst (or cysts) and to the presence or absence of chronic pulmonary emphysema in the remaining lungs. In the first 2 groups the remaining lungs are apparently normal, but while in the first group the large air cyst communicates freely with the bronchial tree, in the second group the communication is intermittent or poor. The major and unique finding in the first group is that of a considerable dead space ventilation with no interference with the excellent performance of the chest bellows, and of respiratory gas exchange. In the second group, a varying degree of ventilatory insufficiency develops, depending on the size of the cyst (or cysts) and the pressure conditions within them, which eventually may result in collapse of the remaining normal lung and considerable mediastinal displacement. While in the first group surgical resection is optional, it is mandatory in the second group. At all events, whether it is limited to the resection of the air cyst, to a single lobe, or involves removal of an entire lung, surgery will be followed by improved respiratory function, sometimes restoration to normal. In a third group, the large air cyst (or cysts) complicate generalized, bilateral chronic pulmonary emphysema. Two such groups have been isolated, depending on whether or not severe alveolorespiratory insufficiency is present as well as ventilatory insufficiency. Surgical resection of the air cyst in the first subgroup where the degree of pulmonary emphysema is moderate and the arterial blood O_2 saturation normal may be beneficial and well tolerated. In the second subgroup, where the degree of pulmonary emphysema is more severe and the arterial blood O_2 saturation reduced to varying extent, attempts at resection have thus far led to postoperative death, and apparently are not justified. (Authors' summary.)

733. Bruce, R.A., Lovejoy, F.W., Jr., Yu, P.N.G. and McDowell, M.: Relationships of vital capacity and ventilatory measurements to physical fitness in patients with cardio-respiratory diseases. Proc. Soc. Exptl. Biol. Med. 74: 398-401, 1950.

Various ventilatory measurements, i.e., those of vital capacity, maximum mask breathing capacity, mean exercise ventilation, % breathing requirement, % breathing reserve, mean exercise mid-capacity and % ventilation, were made on 44 randomly selected patients, aged 15-61, with a variety of cardiorespiratory diseases. The exercise tests consisted of walking on a treadmill for 10 min., if possible. A significant relationship was found between the physical fitness index, scored from an integration of the most reproducible characteristics of circulatory and pulmonary performance during standardized exercise, and the % ratio of the observed to predicted vital capacity. The limitations of this relationship, as well as other relationships of physical fitness score to various ventilatory measurements, are discussed.

734. Bruce, R.A., Lovejoy, F.W., Jr., Yu, P.N.G., Pearson, R. and McDowell, M.: Further observations on the pathological physiology of chronic pulmonary granulomatosis associated with beryllium workers. Am. Rev. Tuberc. 62, No. 1-A:29-44, 1950.

Three more cases of chronic pulmonary granulomatosis associated with Be compounds have been studied with reference to pulmonary and circulatory functional capacity. Despite obvious variations in clinical patterns of disease between patients, certain nonspecific trends of functional disturbance appear common to most of these patients. These are: restricted

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complemental air volume, increased mid-capacity-arterial O_2 gradient, hypoxemia and hyperventilation on exertion. The complexity of factors contributing to the widened O_2 gradient is discussed. A general quantitative estimate of disability in relation to moderate exercise is expressed in terms of the physical fitness index. Untoward responses to continuous O_2 therapy are recorded. (Authors' summary.)

735. Ruyssen, L.: L'examen de la fonction respiratoire dans la pratique courante de la médecine du travail et de l'expertise. (Examination of respiratory function currently in practice in both industrial medicine and research.) In: Études sur la Fonction Respiratoire au Cours de la Silicose. Journées Lorraines de la Silicose, Nancy-Merlebach, 12-13 Déc., 1950, pp. 44-72.

Following a discussion of various systematic examinations of respiratory function, e.g., thorough determinationof all etiologic factors, clinical examination, including X-ray, spirographic and orthodiagraphic studies, the author reports on specific studies carried out since May, 1950, in 260 patients suffering from silicosis. 146 spirograms were done in the course of the investigation described here. The examinations of pulmonary ventilation are discussed with regard to different types of silicosis, e.g., pseudotumorous, confluent-nodular, nodular and reticulonodular. Case reports, radiographs, spirograms and other results obtained from the detailed studies are included. In conclusion, the author emphasizes the importance of spirographic studies for the evaluation of respiratory deficiencies, particularly in cases of silicosis. Various problems are yet to be solved with regard to the alveolar as well as tissular phases and also concerning blood circulation.

736. Austrian, R., McClement, J.H., Renzetti, A.D., Jr., Donald, K.D., Riley, R.L. and Cournand, A.: Clinical and physiologic features of some types of pulmonary diseases with impairment of alveolar-capillary diffusion. The syndrome of "alveolar-capillary block". Am. J. Med. 11:667-85, 1951.

Twelve additional cases with various diffuse diseases of the lungs characterized physiologically principally by interference with the diffusion of O_2 across the alveolar capillary septum have been studied. The patients in this group included 2 with pulmonary granulomatosis following exposure to Be; 1 with pulmonary granulomatosis of the Boeck's sarcoid type; 1 with pulmonary granulomatosis of undetermined etiology, in which the granulomatous lesion contained unusually large numbers of foreign body-type giant cells and birefractile crystals; 1 patient with scleroderma; 3 patients with pulmonary fibrosis of unknown etiology (in 1 case after exposure to Be, in 2 cases associated with granulomas in other organs) and 4 cases in which a diagnosis could not be made. The physical characteristics and diagnoses and also the physiologic data of these 12 are tabulated. The pattern of pulmonary dysfunction consisted of (1) reduced lung volumes, (2) maintenance of a large maximum breathing capacity, (3) hyperventilation at rest and during exercise, (4) normal or nearly normal arterial O_2 saturation at rest but a marked reduction of the arterial O_2 saturation after exercise, (5) normal alveolar O_2 tension, (6) a reduced O_2 diffusing capacity and (7) pulmonary artery hypertension. In some severe cases the dead space-like ventilation and the venous admixture-like perfusion was increased. These findings have been interpreted as an indication of the inhomogeneous nature of the pathologic process. The clinical findings have been analyzed in the light of the physiologic data and the evolutionary trends, both clinical and physiologic, have been described. Because the major pathologic changes are localized in the alveolar capillary septa and because the major physiologic defect is a reduction of the permeability of the alveolar capillary membrane for O_2,

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Austrian, R. et al. (continued)
the name "alveolar-capillary block" has been tentatively offered to describe this syndrome. The case histories of each patient are given in detail.

737. Brown, J.H.U., Hatch, T.F. and Cook, K.M.: A new apparatus for the partitioning of expired air. Rev. Sci. Instr. 22:81-3, 1951.
An apparatus is described for partitioning of exhaled air into 7 separate fractions beginning with the earliest portion of upper respiratory air and continuing to the terminal fraction of deep-lung air. The same volumetric fractions from successive exhalations are collected over a test period of any practical duration. This apparatus has been employed for the study of lung retention of inhaled particulate matter with particular reference to the separate estimate of upper respiratory retention and penetration to and deposition of particulate matter in alveolar spaces. The apparatus is employed with a mechanical respirator of the Drinker type, which fixes the respiratory pattern at any desired frequency and tidal volume. (Authors' summary.)

738. Knott, J.M.S. and Christie, R.V.: Radiological diagnosis of emphysema. Lancet I:881-8, 1951.
On the basis of a study of 20 patients with a clinical diagnosis of moderate or severe emphysema and 20 controls with no evidence of chronic bronchitis, asthma or any other abnormality of the cardiovascular or respiratory systems, it is concluded that a radiological diagnosis of emphysema based on a single postero-anterior film on full inspiration is of doubtful significance. A more reliable assessment may be made from films taken in the postero-anterior and lateral positions, in both inspiration and expiration, but even on this evidence about 10% of cases will be missed and a few normal persons wrongly diagnosed as having emphysema. The radiological features of emphysema are discussed.

739. Bates, D.V.: The uptake of carbon monoxide in health and in emphysema. Clin. Sci. 11:21-32, 1952.
A simple method is described for the estimation of the rate of uptake of CO gas. Variations in the uptake of CO in normal subjects with differing respiratory rates and tidal volumes are described, and it has been shown that hyperventilation increases the volume of gas absorbed but lowers the percentage of the gas removed from the inspired air. These effects are modified if the hyperventilation is accompanied by exercise. The rate of uptake of CO has been measured in 43 cases of exphysema, and is shown to be considerably reduced in comparison with normal subjects: 29% of inspired gas in the group with emphysema as compared with 53% of inspired gas in the young normal group and 47% in the old normal group. The difference in uptake between the young normal and old normal groups in this series is not significant. It is considered that this indicates that much of the inspired air is not coming into contact with pulmonary blood.

740. Branscomb, B.V. and Wright, G.W.: Effects of controlled low oxygen breathing upon exchange of respiratory gases in humans. Federation Proc. 11:16, 1952.
Minute ventilation was maintained at a selected constant rate and tidal volume throughout each experiment. Each subject fasted 12 or more hr. and was recumbent 60 min. prior to the measurements. Gas exchange was measured continuously by the open circuit method throughout the following consecutive periods: period A, respiring room air without controlled breathing pattern for 20 min.; period B, respiring room air (pO_2 = 148-153 mm. Hg) with controlled breathing pattern for 30 min.; period C, respiring nitrogen-oxygen

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Branscomb, B.V. and Wright, G.W. (continued)
mixture (pO_2 = 105-115 mm. Hg) with controlled breathing pattern for 60 min.; period D, respiring room air with or without controlled breathing pattern for 20 min. Arterial Hb saturation was followed by oximetry and periodic direct measurements in several experiments. Fifteen studies on 6 normal male subjects were made. CO_2 output remained remarkably constant throughout all periods. In the majority of the experiments there was a significant decrease of O_2 uptake during period C. This finding was not uniform as to quantitative aspects or repeatability. In 7 experiments the reduction of O_2 uptake was more than 10% of the control level, the greatest reduction being 40%. (Authors' abstract.)

741. Cournand, A.: The syndrome of "alveolar-capillary block." Clinical, physiologic, pathologic and therapeutic considerations. Rept. Ann. Meeting and Proc., Roy. Coll. Phys. and Surgeons 1952:34-47.

The syndrome, called "alveolar-capillary block," caused by a variety of pathologic processes and characterized histologically by alterations of the pulmonary diffusing surface, i.e., the alveolar capillary septa, and physiologically by a reduction in the O_2 diffusing capacity of the lungs is discussed as to its history, etiology, pathology, symptomatology and physiological characteristics. The course of development of this syndrome is somewhat variable; the possibilities are reviewed. The effects of cortisone hormone and ACTH therapy are also variable; the case history of 1 patient successfully treated with cortisone is given.

742. Drutel, P. and Dechoux, J.: Un test spirographique de la perméabilité bronchique: le rapport de la capacité pulmonaire utilisable à l'effort avec la capacité vitale. (A spirographic test of bronchial permeability: the relationship of first second timed vital capacity to vital capacity.) J. franç. méd. et chir. thorac. 6:517-42, 1952.

The first second timed vital capacity (T.V.C.) is the volume of gas expired during the first second of a maximal, forceful expiration, following a complete inspiration. In normal subjects, the absolute values for T.V.C. show great variations, depending on the individual subject, but they are always at, or exceed, 70% of the vital capacity (V.C.).

The ratio T.V.C. X 100/V.C. is useful for the distinction of 3 types of ventilatory insufficiency: a) due to a decrease of only V.C. with normal ratio (reduced thorax expansion), b) due to a decrease of only T.V.C. resulting in a lower ratio (emphysematous bronchitis) and c) due to a combination of a) and b), causing a decrease in the ratio (pulmonary emphysema).

The T.V.C. represents the average rate of gas flow during the first second of a maximal, forceful expiration. It may be compared with the maximum minute ventilation which function it aids to determine in an indirect manner.

A reduction of the ratio T.V.C. X 100/V.C. is observed in conditions characterized especially by an impairment of the respiratory flow rate. Both clinical and experimental evidence show that the latter demonstrates disturbances in the bronchial permeability. The measurement of this function, simple in procedure and easy in the interpretation of the results, helps in evaluating spirographically the bronchial permeability, an essential factor in the study of ventilatory insufficiency. (From authors' summary.)

743. Filley, G.F., Gregoire, F. and Wright, G.W.: Significance of increased alveolar-arterial oxygen tension difference during exercise. Federation Proc. 11:210, 1952.

Alveolar and arterial O_2 tensions were determined in 36 normal men aged 23-60 breathing air at rest and during exercise requiring an average O_2 consumption of 1.08 l./min./m.^{2}. The alveolar pO_2 was calculated from the

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Filley, G.F. et al. (continued)
alveolar equation substituting arterial pCO_2 for alveolar pCO_2. Arterial gas tensions were determined by a modification of the Riley bubble method. The mean difference between alveolar and arterial pO_2 was 9.7±5.27 mm. Hg at rest and 19.6±4.74 mm. Hg during exercise. Of the 4 commonly given explanations for an Aa (alveolar-arterial) difference at rest or during exercise, viz., (1) failure of pulmonary capillary blood to reach alveolar O_2 tension ("membrane factor"), (2) the admixture of venous or partially oxygenated blood with pulmonary capillary blood ("venous admixture"), (3) a change in the physicochemical state of the blood in transit from lung to artery and (4) analytical errors, the membrane factor or venous admixture appear to be the most likely. On the assumptions that there is no membrane factor at rest and that the same percentage of venous admixture occurs during exercise as occurs during rest, calculation from the data predict that the Aa difference during exercise should be increased by approximately the values actually observed in this study. This constitutes evidence that it is not necessary to postulate a membrane factor in order to explain the increase of Aa difference that occurs during exercise.

744. Fowler, W.S., Cornish, E.R., Jr. and Kety, S.S.: Lung function studies. VIII. Analysis of alveolar ventilation by pulmonary N_2 clearance curves. J. Clin. Invest. 31:40-50, 1952.

Measurements were made on successive breaths, during the elimination of pulmonary N_2 while breathing 99.6% O_2, of (1) the mean expired N_2 concentration, (2) number of breaths and (3) tidal volume. Equations with which the data have been described and analyzed are presented. The equations assume that uneven alveolar ventilation is of a regional nature. The lungs, both in healthy young and old subjects and in patients with cardiorespiratory disease, are, in varying degrees, ventilated unevenly, i.e., certain regions appear to be ventilated more rapidly than other regions. The volumes and respective ventilation rates of these several regions can be determined, as well as the volume and average ventilation rate of the lungs as a whole. The extent of uneven ventilation can be measured quantitatively by the resulting delay in pulmonary N_2 clearance. This is determined relative to the rate of N_2 clearance which the subject would have achieved, breathing in the same manner, if alveolar ventilation had been uniform throughout the lungs. This measurement is uninfluenced by the magnitude of the respiratory dead space. In effect, a control and test procedure are done simultaneously for each subject. In 10 healthy young adults, breathing quietly in the semireclining position, N_2 molecules remained in the lungs an average of 7.6 breaths or 36 sec. This was 20% longer than if ventilation had been uniform. In 7 elderly subjects N_2 molecules remained an average of 11.1 breaths, or 41 sec. The increase in the average number of breaths was due to a smaller effective ventilation/breath and to a greater extent of uneven ventilation. Abnormally uneven ventilation was found in almost all of 19 patients with cardiorespiratory diseases, including asthma, emphysema, congestive heart failure and others. The delaying effect of uneven ventilation can be overcome if the total minute volume of alveolar ventilation is large in relation to the functional residual capacity. 27 of the subjects were also examined by another method of estimating the magnitude of uneven ventilation, which is based on the variation in N_2 concentration of alveolar gas expired after a single maximal inspiration of O_2. There was general agreement between the 2 methods, the relative utility of which is discussed. The functional residual capacity, measured from the pulmonary N_2 clearance curves, agreed satisfactorily with simultaneous measurements by the method of Darling and coworkers. Analysis of the N_2 clearance curves permitted an estimate of the error of the Darling method. This amounted to about a 5%

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Fowler, W.S. et al. (continued)
systematic underestimate in emphysematous subjects, resulting from the failure of the terminal alveolar gas sample to represent accurately the mean alveolar N_2 concentration. Although the method presented permits an improved description of alveolar ventilation, a final interpretation of such data must await further study of the spatial distribution and the controlling mechanisms involved in alveolar ventilation. (Authors' summary.)

745. Gough, J., Fletcher, C.M., Gilson, J.C. and Oldham, P.D.: Discussion on diagnosis of pulmonary emphysema. Proc. Roy. Soc. Med. 45:576-86, 1952.
Dr. Gough discusses the large section technic in the pathological diagnosis of emphysema and reviews the pathological characteristics of the 2 different types of chronic emphysema. Dr. Fletcher demonstrates that the clinician is unable to diagnose the early stages of emphysema. In an experiment in which 8 doctors separately examined 20 patients by assessing 11 physical signs, the observers' range of disagreement in diagnosing each of the signs was 19-33%. Drs. Gilson and Oldham show that a single physiological index is an unsatisfactory method of assessing emphysema, but that a combination of several tests, combined in the form of a discriminant function, provides better separation of the normal from the abnormal. Intrapulmonary gas mixing (open-circuit method), maximum breathing capacity, residual capacity % of total lung capacity and functional residual capacity are demonstrated to be the most important functions to be tested.

746. Hatch, T.F.: Carbon monoxide uptake in relation to pulmonary performance. Arch. Ind. Hyg. and Occupational Med. 6:1-8, 1952.
The relationships of CO uptake with pulmonary performance are mathematically developed, and the following conclusions are drawn. (1) In man, the rate of CO uptake in relation to pulmonary performance follows the simple exponential equation for respiratory exchange of inert gases. (2) The rate of uptake varies directly with atmospheric concentration since the physiological "solubility" of CO in blood increases with decreasing atmospheric concentration of the gas. (3) The rate of uptake is independent of the pulmonary circulation rate. At rest, it is primarily dependent upon lung ventilation. Under hard exercise, the diffusion area of the lungs does not increase in proportion to the rise in ventilation rate. Consequently, the rate of CO uptake is about equally dependent upon ventilation rate and diffusion capacity.

747. Marshall, R., Bates, D.V. and Christie, R.V.: Fractional analysis of the alveolar air in emphysema. Clin. Sci. 11:297-307, 1952.
A simple apparatus for the partition of expired air into a number of samples is described. Fractional sampling of the expired air was carried out in 14 normal subjects and in 26 patients with emphysema. The O_2 and CO_2 content of the fractional samples was determined. The results indicate that in emphysema the last part of the air expired has been in contact with underventilated blood. In other words, the ratio of ventilation to perfusion falls as expiration progresses. In 1 patient with severe emphysema, voluntary hyperventilation failed to improve the ventilation of the blood in contact with the last part of the air expired. (Authors' summary.)

748. Bates, D.V.: In discussion: McKerrow, C.B. et al.: The assessment of respiratory function. Proc. Roy. Soc. Med. 46:532-41, 1953.
There are three methods whereby the evenness of inspired gas distribution within the lungs is measured, viz., analysis of gas composition of a single breath, analysis of the rate at which equilibrium is reached in a closed

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Bates, D.V. (continued)
system and measurement of the rate of gas replacement in the lungs using an open circuit system; all lead to the same over-all results. The method of measuring the efficiency of blood ventilation by the use of CO is discussed. It has been shown that the % CO uptake is dependent on the balance between ventilation and diffusing capacity within the lung, and the finding of a lowered % CO uptake indicates that the "blood gas interchange" in the well ventilated parts of the lung is not normal. Those using the CO technic have found that it appears to be a sensitive index of the severity of emphysema and to be, therefore, of considerable prognostic value.

749. Boothby, W.M., White, C.S., Levin, L., January, H.L. and MacQuigg, R.E.: Rate of pulmonary and tissue gaseous nitrogen elimination as a measure of pulmonary efficiency. J. Am. Med. Assoc. 152:1000-3, 1953.

The N_2 meter, which measures the rate and amount of gaseous N_2 eliminated into a closed circuit respiration apparatus by the patient while he is breathing O_2, is described. Several types of observations of pulmonary efficiency are possible with this instrument. The time required to lower below 1/2 the average pressure of gaseous tissue N_2 in the body of normal persons in the steady state can be calculated. The data of accumulated pulmonary and tissue N_2 elimination, when the patient is breathing O_2, can be expressed as a function of time. It is possible in most cases to determine with accuracy the volume of the N_2 in the residual air. The time required under basal conditions to wash out the functional residual air of normal subjects, breathing O_2, can be determined. The tidal air and the vital capacity, which is composed of inspiratory and expiratory reserve air, are determined. It has been reported that under strictly standardized conditions the quantitative registration of the severity of asthma in provocation tests in patients suffering from asthma was studied. Three examples in which the rate and the amount of pulmonary N_2 elimination was studied in addition to the usual diagnostic procedures for estimating pulmonary efficiency are presented. One is a normal person; another is a patient with decreased residual N_2, indicating an exceedingly small volume of functioning pulmonary tissue, that is, of freely open alveoli; the 3rd is a patient in whom the residual N_2 is very greatly increased, probably from several causes, such as dilatation of alveoli, cavities and intrathoracic tumor tissue.

750. Dulfano, M.J., Herschfus, J.A. and Segal, M.S.: Timed vital capacity in bronchial asthma. J. Allergy 24:309-15, 1953.

Eighty-two timed vital capacity measurements were studied in 36 patients with chronic bronchial asthma during (a) the symptom-free stage, (b) "spontaneous attacks" and (c) experimentally induced attacks of "asthma." Symptom-free patients had a 1st second to total vital capacity ratio of 57.5%. There was no significant change of the ratio after medication, although the component parts of timed vital capacity were improved. The patients with spontaneous acute asthma had a 1st second to total vital capacity ratio of 58.1%. This ratio decreased after the attack was relieved, because of increase in total vital capacity rather than decrease in 1st second. The patients with experimentally induced "asthma" had a ratio of 52%. The ratio and its response to treatment showed a very close relationship to results obtained in spontaneous asthma. Improvement in the total vital capacity, although subject to some criticism, may be employed as a guide to measure the over-all improvement of the asthmatic patient under treatment. Timed vital capacity and all of its subdivisions represent a valuable technic for the quick estimation of the basic ventilatory disturbances. A decreased ratio of 1st second vital capacity to total vital capacity, in the presence of a markedly diminished total vital capacity, is a definite indication of

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Dulfano, M.J. et al. (continued)
the presence of obstructive ventilatory insufficiency. However, the ratio of 1st second to total vital capacity, considered alone, does not represent a valuable index of the degree of improvement of the asthmatic patient under treatment. (Authors' summary.)

751. Filley, G.F., MacIntosh, D.J. and Wright, G.W.: Carbon monoxide uptake at rest and during a steady state of exercise. Federation Proc. 12:Abst. No. 662, 1953.

The rate at which CO is removed from an inspired mixture of 0.1% CO in air has been measured in 10 normal subjects and in 30 cases of pulmonary disease at rest and during 6-min. periods of moderate to exhausting exercise. The CO uptake/mm. of alveolar CO tension (D'co) was calculated by the Bohr relation from simultaneously determined arterial blood and expired CO_2 tensions. Since no evidence was obtained of an increasing back pressure of CO in the blood, D'co was considered to be dependent on the ratio of the alveolar hemoglobin diffusing surface to the thickness of the alveolar walls. CO uptake at rest was primarily a function of ventilation and the fraction of CO removed from respired gas (CO_F) remained fairly constant for a given subject. During increasingly severe stints of exercise, the CO uptake failed to keep pace with the increase of ventilation and the CO_F progressively declined. Normal values for D'co at rest ranged from 13-26 cc. CO/mm. alveolar pCO. During progressively severe exercise, D'co reached a plateau approximately twice the resting figure for a given subject. In pulmonary granulomatosis, striking reductions of CO_F and D'co were found.

752. Hatch, T., Cook, K.M. and Palm, P.E.: Respiratory dead space. J. Appl. Physiol. 5:341-7, 1953.

For the calculation of anatomical dead space one should use the average CO_2 concentration in the lung gas which is normally exhaled since this represents the gas mixture involved in active lung ventilation. This has been done in a series of 100 tests here reported. Exhaled air was collected in a series of equally-timed fractions by means of a partitioning valve synchronized with the breathing cycle which was controlled, in turn, by a mechanical respirator. Breathing frequency was fixed at 6, 12, 15 and 20 rpm and the tidal volume ranged in the tests from 400-2500 cc. The average CO_2 concentration in the last 200-400 cc. of the exhalation, after upper respiratory washout, is shown to represent the lung gas which is in active exchange with the outside atmosphere. For 5 subjects, the average anatomical dead space was found to be 130 cc. (0=±30 cc.). This agrees well with the volume calculated from physical measurements of the respiratory tree. There was no apparent change in dead space volume with increasing tidal volume or with changes in breathing frequency. These results support the suggested separate measurement of anatomical dead space and indicate that a sizeable terminal fraction of normally exhaled air must be taken to represent the average CO_2 concentration in the actively ventilated portions of the lungs. Neither the common forced-exhalation sample nor a small gas sample collected at the end of a normal exhalation will give meaningful values. (Authors' summary.)

753. Kennedy, M.C.S.: A practical measure of the maximum ventilatory capacity in health and disease. Thorax 8:73-83, 1953.

The vital capacity, recorded on a fast-revolving drum during expiration and inspiration, has been termed the vital spirogram. It is shown that the expiratory phase of this vital spirogram (E.V.S.) has an initial linear fraction, the volume and rate of air flow of which is clearly related in shape to that seen during the expiratory phase of maximum voluntary

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Kennedy, M.C.S. (continued)
ventilation (M.V.V.). It is shown that the slope of the 1st steep fraction of the E.V.S. correlates well with the expiratory phase of the M.V.V. tracing in 27 patients ($r=+0.975$). Consecutive E.V.S. tracings are remarkably constant for a given individual for an occasion, though they may vary from day to day if there is a change in the factors influencing air flow. The tidal volume and rate of breathing during voluntary hyperventilation have been studied in 332 pottery workers and Cornish tin miners. It was found that these subjects breathed the greatest volume of air in unit time at a respiratory rate of between 44 and 55 breaths/min. Their maximum ventilatory capacity, therefore, depended on their tidal volume when breathing between these rates. Half the mean expiratory flow rate over the 1st 0.75-sec. period of 6 consecutive E.V.S. tracings has been termed the E.F.R.^{40}, since the 0.75-sec. period is equivalent to a theoretical breathing rate of 40 breaths/min. The E.F.R.^{40} is readily obtained from the E.V.S. tracings by the use of a transparent protractor. In 50 patients with chronic lung diseases, the correlation coefficient (r) of the E.F.R.^{40} test and the M.V.V. test was +0.93. The E.V.R.^{40} test is a better measure of the maximum ventilatory capacity than the M.V.V. test, because it is easier and quicker to do and has a small standard error (S.E.=±5%). It is suggested that the measurement of ventilatory rates, using the E.F.R.^{40} test, should prove a useful method of estimating the maximum ventilatory capacity of individuals in hospital and field work, and especially for the assessment for compensation of patients with pneumoconiosis. The vital capacity is only a valid measure of the maximum ventilatory capacity when most of the vital capacity is expelled at a uniform rate and when this rate is proportional to the vital capacity. The E.F.R.^{40} is a measure of that part of the vital capacity which is of use to the subject for hyperventilation. (Author's summary.)

754. Wright, G.W., Gregoire, F. and Filley, G.F.: Maximum achievable oxygen uptake during physical exercise of six minutes' duration correlated with other measurements of respiratory function in normal and pathological subjects. Federation Proc. 12:Abst. No. 526, 1953.

180 persons, 41 of whom were normal men and the remainder suffering from pulmonary diseases, were walked for 6 min. on the treadmill at increasing grades until an intensity of exertion that could not be maintained for 6 min. was reached. Among other measurements, the O_2 uptake and minute ventilation were determined by the open-circuit method during the last 2 min. of each stint of exercise. The correlation between various conventional measurements of the respiratory apparatus and of gas exchange with the highest O_2 uptake/min. achieved by each subject has been studied. The highest correlation, using the group as a whole, was found to be with a combination of the maximum breathing capacity and the O_2 ventilation equivalent, 'r' being 0.904, S.E. 0.014. For the normal persons alone, this correlation had an 'r' of 0.720, S.E. 0.81.

755. Yu, P.N.G., Lovejoy, F.W., Jr., Joos, H.A., Nye, R.E., Jr. and McCann, W.S.: Studies of pulmonary hypertension. I. Pulmonary circulatory dynamics in patients with pulmonary emphysema at rest. J. Clin. Invest. 32:130-7, 1953.

Hemodynamic studies are reported in 18 patients with pulmonary emphysema at rest. The degree of pulmonary hypertension varied directly with the severity of emphysema, hypercapnia and anoxia. "Pulmonary capillary" pressure was normal in all cases. The pulmonary artery-"pulmonary capillary" pressure gradient exceeded normal in 11 patients and correlated significantly with pulmonary artery pressure and with the severity of hypercapnia.

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Yu, P.N.G. et al. (continued)

Total pulmonary resistance and pulmonary arteriolar resistance exceeded normal in all instances of pulmonary hypertension but correlated well only with the degree of CO_2 retention. Cardiac output and index were variable. Cardiac index correlated negatively with the total pulmonary resistance. The O_2 saturation of arterial blood varied inversely with mean pulmonary artery pressure but did not parallel the other determinants. The O_2 tension of arterial blood did not vary predictably with any of the determinants. The CO_2 tension of arterial blood correlated closely with mean pulmonary artery pressure, total pulmonary resistance and pulmonary arteriolar resistance, but not with the "pulmonary capillary" pressure. The ratio of residual volume to total capacity (RV/TC) varied directly with mean pulmonary artery pressure and total pulmonary resistance. Certain mechanisms in the pathogenesis of pulmonary hypertension are dicussed in detail. The role of anoxia is confirmed and attention is directed to the probable importance of CO_2 retention in elevating pulmonary artery pressure and increasing pulmonary vascular resistance. (Authors' summary.)

756. Arnould, P.: Les limites de la mesure du débit cardiaque. (The limits of measuring the cardiac output.) Rev. Méd. Nancy 79:658-68, 1954.

The author discusses the accuracy that can be expected in measuring the cardiac flow according to the method by Fick and Stewart-Hamilton by analyzing the various steps necessary in carrying out the technic. Due to numerous physiologic factors, the application of the method is possible in only a limited number of cases, which is discussed in detail. The author stresses the necessity of considering all physiologic conditions before deciding on a test method. He concludes from the results of his study that it is not entirely satisfactory to measure the cardiopulmonary blood volume by means of a dye method. (From author's summary.)

757. Arnould, P., Bonfante, N. and Petiteville, P.: Les limites de l'oxymétrie. (The limits of oximetry.) Rev. Méd. Nancy 79:683-700, 1954.

Following a brief discussion on the principles of oximetry, the authors express their opinion as to the accuracy that can be expected in the use of this technic. Their experience is based on working with 3 types of apparatus (those by Millikan, Wood and Brinkmann) which are employed in the study of human subjects as well as of dogs. The authors detected numerous sources of error, some of which are discussed in this paper. Tabulated data representing the results obtained by the oximetric method should be critically studied. (From authors' summary.)

758. Drapier, Y. and Chabot, B.: Les modifications ventilatoires apportées par la thoracoplastie. (Modifications in ventilation brought about by thoracoplasty.) Rev. Méd. Nancy 79:773-9, 1954.

The authors examined 79 patients before and following thoracoplasty, the tests of pulmonary ventilation being carried out at various intervals. The results demonstrate that 1 year after the operation, the lung functions were stabilized. The decrease of vital capacity was about 16% as compared with the values obtained before surgery, in cases involving the operation and replacement of 4-5 ribs, 20%, where 6 ribs were involved and 23% for thoracoplasty of 7-8 ribs. The corresponding decreases in the results obtained for first second timed vital capacity were: 18, 20 and 30%.

The influence of the type of operation is demonstrated in the tabulated values for vital capacity and first second timed vital capacity. (From authors' summary.)

759. Drutel, P. and Magnin, P.: Les épreuves pharmacodynamiques de la ventilation pulmonaire. (Pharmacodynamic tests of pulmonary ventilation.) Rev. Méd. Nancy 79:629-37, 1954.

The administration of cholinergic and adrenergic drugs by inhalation is the most practicable and less hazardous. Acetylcholine and adrenaline aerosols aid in demonstrating possible changes in vital capacity (V.C.) and first second timed vital capacity (T.V.C.) which are determined before and after the administration of the drugs. The authors state that the use of acetylcholine should be preferred to that of aleudrine, since the former substance provides a more sensitive test. Aleudrin is suitable for testing subjects with a marked ventilatory disorder.

An aerosol of acetylcholine chloride, at a concentration of 1.0%, should not be administered for >3min. If the subject is suffering from asthma, it is imperative to spirographically check every 30 sec. and to discontinue the test at once upon appearance of the characteristic symptoms in order to avoid severe dyspnea.

The administration of aleudrin, at a concentration of 0.002 g./cc. of solution, should extend over 2 min., and the pulse rate should be checked throughout the application.

In normal subjects, tests carried out with acetylcholine revealed changes of <10% in both V.C. and T.V.C. However, in asthma patients, the changes were much more noticeable and ranged from 30-70%, being either parallel or affecting the T.V.C. to a greater extent. This reduction in lung function may appear already after 15-30 sec. of inhalation and may be induced with concentrations as low as 0.5%.

A third group of subjects tested, those suffering from chronic pulmonary conditions, showed moderate sensitivity and provided values lying between those obtained from the first 2 groups mentioned. The results from testing these subjects showed wide variations; the diagnosis "asthma-type" disease seems indicated.

The significance of pharmacodynamic tests, especially from the diagnostic and therapeutic points of view, is discussed. (From authors' summary.)

760. D'Silva, J.L. and Kazantzis, G.: Measurement of the mechanical function of the lung of normal subjects. Thorax 9:128-35, 1954.

In the lung function tests reported here, the subjects studied were normal male medical students and some male patients with minor ailments not connected with the respiratory system, all <35 yr. of age. Both the spirometer and the fast-moving (28.5 mm./sec.) kymograph used had been tested for accuracy at the respiratory rates used. The fast vital capacity (F.V.C.), i.e., expiration of the full volume, as quickly and completely as possible, was measured 4X/subject. The maximum ventilatory capacity (M.V.C.) of 16 medical students was measured at repiratory rates ranging from 20 to 70/min. This test was performed once and was preceded and followed by 3 determinations of capacity (V.C.), the mean of the 6 measurements being taken as the V.C. volume. The tidal volume in each M.V.C. tracing was measured and for each respiratory rate the tidal volume, expressed as a percentage of the V.C. volume, is referred to as the "swept fraction." This figure diminished as the respiratory rate increased. At each respiratory rate the swept fraction varied considerably among the different subjects, and the scatter was much the same at all the rates of breathing included in the tests. When the performances of different subjects are compared, a close exponential relation is revealed between the unswept fraction and the duration of a respiratory cycle. Average values and standard deviations of the swept fractions at 20, 30, 40, 50, 60, 70 and 80 respirations/min. are tabulated. The total volume of air expired in each F.V.C. test was measured. The mean volume in 4 trials is referred to as the F.V.C. volume, and the average for 21 subjects

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was 1.01 X (range 0.92-1.08 X) the volume recorded in the usual slow determination of V.C. In the F.V.C. curves produced by different normal subjects, there is close similarity, although the time needed for expiration varies a little. In emphysema patients, the time may be several times longer than that required for normal subjects.

The normal F.V.C. curve is shown to be a hyperbola which is very similar to an exponential curve with a time constant of 0.47 sec. There is a high correlation between the M.V.C. and the results of the F.V.C. test. Thus, at 30 respirations/min., the coefficient of correlation for M.V.C. and the volume of air expired in 1 sec. in the F.V.C. test is 0.93 In assessing the mechanical function of the lungs, the authors estimate the subjects' performances at 3 respiratory rates and compare them with the standard "normal" figures determined by the observer carrying out the test. The measurements of performances in the F.V.C. test shows promise of greater value than that of the M.V.C. test. It is strongly urged that each laboratory should determine its "normal" values, because the tests are not performed entirely independent of the observer.

761. Graimprey, J.: Les valeurs "dites normales" en spirographie. (The "so-called normal" values in spirography.) Rev. Méd. Nancy 79:648-57, 1954.

The author carried out a study on 500 subjects, representative of the population of Lorraine. The variations in the spirographic values obtained are discussed with reference to age differences.

In persons of up to 23 yr. of age, the vital capacity (V.C.) and the first second timed vital capacity (T.V.C.) values increase. From 23 yr. on, there is a gradual decrease in these functions, which is estimated as 36 cc./yr. for the V.C. and 40 cc./yr. for the T.V.C. The ratio T.V.C. X 100/V.C., sometimes called the coefficient of the utilization of the V.C., decreases with increasing age, i.e., from 83% at 20 yr. to 68% at 75 yr.

The author considers the test of maximum breathing capacity a difficult one, complex in technic, exerting for the subject and providing results of limited accuracy. Presented in graphical form, the values obtained follow the same crescent shape that is observed in representations of V.C. values.

Even with cooperative subjects, the values obtained from testing the ventilation/min. show great variations under the present laboratory conditions.

762. Lamarche, M.: Les limites de la mesure de la masse sanguine. (The limits of measuring the blood volume.) Rev. Méd. Nancy 79:669-82, 1954.

Since it is known that certain pulmonary disorders may influence the blood circulation, it seems worthwhile to compare the various methods of measuring the blood flow that are in use today. The author reviews numerous methods and states his preference, i.e., the Chicago Blue 6 B method. The various phases of the technic, as well as physiologic and pathologic factors that might constitute a source of error or might modify the results obtained are discussed. (From author's summary.)

763. Magnin, P. and Sadoul, P.: La ventilation au cours du pneumothorax. (Ventilation in case of pneumothorax.) Rev. Méd. Nancy 79:752-61, 1954.

In the majority of cases, a pneumothorax, if satisfactorily maintained, does not necessarily entail a marked decrease in the values for vital capacity or first second timed vital capacity. It amounts to 20% during the first 6 mo., after which it gradually falls to reach <15%. In some cases, the decrease in these functions is almost nil. In cases of rigid pneumothorax, there is, however, an almost total loss of the function of the underlying lung. The severity of this condition is generally recognized, but the frequency is overestimated. It is difficult to evaluate the prognosis as to the pulmonary function in such cases. Influencing factors are

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Magnin, P. and Sadoul, P. (continued)
adhesiotomy, extensive adhesions producing a noneffective pneumothorax, prolonged conditions of purulent effusion, collapse of lung duration and pachypleuritis, all of which could induce exacerbation. The authors consider the duration of the complications an important factor. For example, if in a case of tubercular empyema, the lung regains its wall within a few mo., the reduction in pulmonary function need only be slight. On the other hand, there is rarely satisfactory lung function in cases of serofibrinous effusion or incomplete collapse extending over prolonged periods of time. (From authors' summary.)

764. Moreau, A., Aubertin, N. and Pivoteau, C.: Les modifications de la ventilation au cours du pneumothorax extra-pleural. (Modifications in ventilation during the maintenance of an extrapleural pneumothorax.) Rev. Méd. Nancy 79:767-72, 1954.

The authors examined and followed up 50 patients before the operation and, at varying intervals, for a period of 2 yr. following it. The tests showed that there is a reduction in both vital capacity and first second timed vital capacity, amounting to 27% for the first 3 mo. after the induction of the extrapleural pneumothorax. With progressing time, the reduction decreases somewhat. 1-2 yr. following the operation, the decrease in the 2 functions tested was only 13%, as compared with the values obtained before the operation. (From authors' summary.)

765. Needham, C.D., Rogan, M.C. and McDonald, I.: Normal standards for lung volumes, intrapulmonary gas-mixing, and maximum breathing capacity. Thorax 9:313-25, 1954.

The lung function tests reported here have been carried out by studying 324 subjects, 183 males and 141 females, during a period extending from June, 1952 through Sept., 1953. The sex distribution in the 3 age groups was as follows: 11-19 yr., 78 M, 72 F; 20-49 yr., 72 M, 42 F; 50-77 yr., 33 M and 27 F. Both the ventilatory and the distributive aspects of the subjects' lung function were studied by testing: total lung capacity (T.L.C.), intrapulmonary gas-mixing efficiency (M.E.%), maximum breathing capacity (M.B.C.) and timed vital capacity (T.V.C.). The subjects were tested in a nonbasal state and in a sitting position. The testing procedures, technics of air sample collection and the determination methods are described in detail. The results were subjected to statistical analysis. The interrelations of the function with age and body measurements were studied and, from numerous regression analyses, equations have been calculated which are presented in graphical and tabulated form. The results, intended to help in the prediction of expected normal values, are discussed with reference to those obtained from previous similar studies. The subjects <13 yr. of age showed no influence of sex on lung function. From puberty on, boys' lung volume and M.B.C. values exceeded those obtained from girls. The latter attain adult values 1 yr. sooner than do boys. In adults, a fall was noted with increasing age in M.B.C., V.C. and F.R.C.(functional residual capacity)/T.L.C. ratio, while there was a slight rise in the R.V.(residual volume)/T.L.C. ratio. Up to 70 yr., no influence of age was observed with regard to M.E.%. The authors conclude that T.V.C. values, in the above study measured by means of a Palmer standard kymograph over 2-sec. periods, provide more conclusive information than do V.C. test results, since the latter give no indication concerning the time required for expiration. (52 references.)

766. Pillot, P.: Compairison de deux méthodes de mesure du volume résiduel circuit fermé. (Comparison of two closed-circuit methods of measuring the residual volume.) Rev. Méd. Nancy 79:638-47, 1954.

There is a great variety of methods for measuring the residual volume. In the study reported here, 2 closed-circuit methods have been compared, and the results are recorded. On the basis of the findings, the author states that the values obtained by the O_2 system of van Veen, Orie and Hirdes are much less representative than are those arrived at by means of the He method. The average coefficients of variation are given as 8.9% for the former and 4.3% for the latter, respectively. Simple procedure and accurate results characterize the He method as eminently preferable for measuring the pulmonary residual volume. (From author's summary.)

767. Sadoul, P.: Exploration de la Fonction Pulmonaire dans les Pneumoconioses. (Study of Pulmonary Function in Pneumocosiosis.) XXVII Congrès International de Médecine du Travail, Médecine Légale et Médecine Sociale de Langue Française, Strasbourg, 1954, 190 pp.

On the basis of results from studies carried out during the past 6 yr. at the Function Test Center at Nancy, the author describes certain pulmonary function tests suitable for patients suffering from pneumoconiosis. According to the author, emphasis is placed on detailed reporting of the test methods rather than on extensive recording of the results. The latter represent values obtained from 127 patients with established pneumoconiosis and 128 normal subjects. Two principal types of test methods are distinguished: a) the analytical, demonstrating the functions per se, such as thoracic mobility or permeability of the alveolar membranes and b) the synthetic, which gives evidence of multiple factors and complex reactions, more difficult to evaluate.

In establishing the degree of pulmonary impairment in patients suffering from pneumoconiosis and subsequent decisions on compensation claims, the results obtained from testing pulmonary functions are a necessary and valuable addition to the information derived from clinical, especially roentgenological examination. These tests should be simple, easy to reproduce and should not involve exertion or hazard for the patient. In addition to measuring vital capacity (V.C.), maximum breathing capacity (M.B.C.) and first second timed vital capacity (T.V.C.) as well as pharmacodynamic tests with acetylcholine and determinations of lung functions during exercise should possibly be carried out. Common errors with regard to procedure and recording are discussed. A comparison of the tabulated values obtained from the 127 pneumoconiosis patients mentioned above with those demonstrated by the controls shows abnormal results throughout for the former, particularly with respect to the ratio T.V.C.:V.C. V.C. was approximately normal in miners with previous exposure in Fe mines; it was decreased in those with a history of exposure to siliceous substances. A decrease of both T.V.C. and the ratio T.V.C.:V.C. was noted in all patients suffering from pneumoconiosis, becoming more evident with advancing age.

A list of pertinent terms, as used by various authors, is included; abbreviations and their definition are tabulated, as suggested at the meeting at Atlantic City, 1950. (235 references.)

768. Sadoul, P. and Bonfante, N.: Épreuves d'hypoxie unilatérale au cours de la bronchospirométrie. (Tests of unilateral hypoxia in bronchospirometry.) Rev. Méd. Nancy 79:711-22, 1954.

Following bronchospirometry, carried out by means of the closed-circuit methods, one lung contains a mixture of low O_2 concentration, the N2 content being 85-99%; the gas mixture in the other lung, however, contains 30% O_2. By use of oximetry, in combination with hypoxia, interesting

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Sadoul, P. et al. (continued)
information may be gained concerning the circulatory functions of the lungs. On the basis of results obtained from studying various patients in the manner described, the authors distinguish in this preliminary report the following 3 main types of lung condition detected: a) no circulatory adaptation is noticed, b) the blood flow in the lung breathing 30% O_2 is higher than that of the other lung. During hypoxia, the pulmonary blood flow in the former lung is increasing further, c) a progressive decrease in saturation is evident. The O_2 consumption of the lung breathing 30% O_2 rises slowly but noticeably. In this case it is not possible to determine that there has been an increase in the pulmonary blood flow. According to the authors' opinion, it is useless to continue the test if the saturation is decreased to $<80\%$ and continues to fall. At a saturation of such a low level, a greater O_2 consumption is not necessarily accompanied by an increased circulation. The possibility that the decrease in these oximetric values may be of only temporary nature and that an adaptation might take place later does not justify a prolongation of a test which represents an exertion for the patient.

The authors conclude that the tests of unilateral hypoxia, even in combination with oximetry, do not, in all cases, suffice to evaluate the circulatory adaptation of the lungs. (From authors' summary.)

769. Sadoul, P., Drutel, P. and Dechoux, J.: Tuberculeux pulmonaires non collabés. (Patients with pulmonary tuberculosis not accompanied by collapse of the lungs.) Rev. Méd. Nancy 79:736-51, 1954.

343 male patients, suffering from pulmonary t.b. but having no history of previous pleural or bronchopulmonary conditions nor collapse of the lungs have been tested. Pulmonary function values have been recorded with regard to decreases in vital capacity, indirect maximum ventilation (Tieffenau) and the ratio first second timed vital capacity X 100/vital capacity.

The reduction in values (obtained by spirographic technic) with increasing age is more marked in t.b. patients than in normal subjects. The degree of severity of the pulmonary lesions is reflected in a proportional decrease of values for vital capacity and maximum breathing capacity, the decrease in both being parallel. The duration of the disease affects the maximum breathing capacity more than the vital capacity of the patients, the length of the evolution process being of greater significance than the age of the lesion. A marked improvement in the clinical picture and in the X-ray pattern may be accompanied by an increase in the values for vital capacity and, to some extent, also for the maximum breathing capacity.

It is important to realize that occasionally, pulmonary t.b. alone, without collapse of the lungs, may induce a ventilatory insufficiency similar to that observed in pulmonary emphysema. (From authors' summary.)

770. Simon, A. and Arnould, P.: Occlusion de l'artérie pulmonaire chez le chien. (Occlusion of the pulmonary artery in the dog.) Rev. Méd. Nancy 79:701-10, 1954.

Employing Carlens' technic, the authors have carried out temporary occlusion of a pulmonary artery in the dog and have analyzed the results with regard to circulation and respiration. The general arterial pressure is not altered, but above the occlusion, the pulmonary arterial pressure is raised. The lung on the side of the occlusion no longer collects O_2; the other lung compensates immediately in such effective manner that the total O_2 intake does not change. With respect to the ventilation, variations are discussed without, however, describing their mechanism.

The test is well tolerated, and it is stated that it also has proved suitable for tests on human subjects. (From authors' summary.)

771. Bates, D.V., Boucot, N.G. and Dormer, A.E.: The pulmonary diffusing capacity in normal subjects. J. Physiol. 129:237-52, 1955.

A respiratory technic using CO is described for the measurement of the pulmonary diffusing capacity during steady state conditions at rest and exercise. The effect of differently calculated values of mean alveolar CO tension on the diffusing capacity is discussed. It is shown that end tidal sampling is essential for a reliable estimate of resting diffusing capacity. On exercise the value calculated from an assumed value of anatomical dead space agrees well with values calculated from measured end tidal samples. It is concluded that this technic is suitable for the measurement of the pulmonary diffusing capacity, and particularly applicable to clinical research since no blood sampling is required. 19 normal subjects have been studied at rest and during exercise on a motor-driven treadmill. The resting diffusing capacity (CO), D_{CO}, is not apparently related to age, sex, stature, functional residual capacity of the lungs, smoking habits or athletic ability. On exercise, however, the D_{CO} is related to the measured functional residual capacity. There was no close correlation with age, but the range of age difference in the group was small. The most athletic subject had a higher D_{CO}, and the oldest member of the series a lower D_{CO} than might have been predicted from their respective lung volumes. The day-to-day variation in resting diffusing capacity in one subject was from 13.5 to 19.9 ml./mm. Hg. The standard deviation of the difference between immediately consecutive estimates on exercise was 1.9. The mean resting D_{CO} was 17.6 ml./min./mm. Hg. At 3 mph on the flat the mean D_{CO} was 30.8, and at the same speed at a grade of 1:10.7 the mean D_{CO} was 31.9. Detailed comparisons between one athletic and one nonathletic subject in the series showed a striking difference between the D_{CO} on maximum effort in the 2 subjects. The athlete reached a D_{CO} of 73.5 and the nonathlete 41.5. There is insufficient evidence as yet to show whether a high grade of athletic ability is dependent on a high D_{CO}. (Authors' summary.)

772. Comroe, J.H., Forster, R.E., II, Dubois, A.B., Briscoe, W.A. and Carlsen, E.: The Lung. Clinical Physiology and Pulmonary Function Tests. Chicago, Ill., The Year Book Publishers, 1955, 219 pp.

A knowledge of the various lung tests is essential in the study of the pneumoconioses as well as other lung diseases. This monograph is written for doctors and medical students, to explain in simple words and diagrams those aspects of pulmonary physiology that are important to clinical medicine. The general headings include: lung volumes, pulmonary ventilation ratios of pulmonary circulation and ventilation to blood flow ratios, diffusion, arterial O_2, CO_2 and pH, mechanics of breathing and clinical applications of pulmonary function tests. Useful data, equations and calculations are presented in an appendix, and a selected list of references is included. (Abst. Ind. Hyg. Dig. 19:633, 1955.)

773. Craig, F.N.: Pulmonary ventilation during exercise and inhalation of carbon dioxide. J. Appl. Physiol. 7:467-71, 1955.

Respiratory minute volumes (V) of 3 men were followed during inhalation of CO_2 mixtures up to 8% (C) and standing, walking or running on a level treadmill at speeds up to 6 mph (M). The conditions were studied in combination up to 6% CO_2 and 4 mph. The results were fitted by the equation $\text{Log } V = d + eC + dM - gCM$ with an average deviation of 2 l./min. In this system the lines representing constant CO_2 concentration or treadmill speed converge and when extrapolated come to a point. It is concluded that while the minute volume was multiplied by factors for CO_2 and treadmill speed, each factor operated so as to diminish the action of the other. (Author's summary.)

774. Farhi, L.E. and Rahn, H.: A theoretical analysis of the alveolar-arterial O_2 difference with special reference to the distribution effect. J. Appl. Physiol. 7:699-703, 1955.

The alveolar-arterial (A-a) O_2 difference can be attributed to 3 independent phenomena: (1) diffusion impairment, (2) admixture of venous blood from sources other than pulmonary capillaries and (3) the existence of unequal ventilation/perfusion ratios among the alveoli. By assuming a distribution of ventilation/perfusion ratios in healthy lungs, the contribution of this phenomenon toward establishing an A-a O_2 difference can be evaluated under conditions of various inspired O_2 tensions. (Authors' summary.) (Highly technical from our point of view. MLT.)

775. Fishman, A.P., Himmelstein, A., Fritts, H.W. and Cournand, A.: Blood flow through each lung in man during unilateral hypoxia. J. Clin. Invest. 34: 637-46, 1955.

The technics of bronchospirometry, cardiac catheterization and cannulation of a peripheral artery have been combined for the application of the Fick principle to the determination of blood flow through each lung in man. The essential features of the method are (1) the separate measurement, by collection of appropriate samples, of the O_2 uptake of each lung, and of the O_2 content of the mixed venous and of the arterial blood, and (2) the assumption that under the conditions of these experiments, the O_2 content of the pulmonary venous blood draining one lung is identical to the O_2 capacity of the arterial blood. This latter assumption was verified by (a) the demonstration of complete arterial blood O_2 saturation, when the subjects in these studies were breathing a mixture of 25% or 33% O_2 in N_2 with both lungs, and (b) a theoretical analysis of experimental data. During unilateral breathing of hypoxic gas mixtures capable of increasing pulmonary arterial pressure when applied to both lungs, no alteration in either total minute flow, or in the distribution of blood flow to each lung was observed. It is therefore concluded that the hypoxic stimulus does not act directly upon either the lung or the post-arterial segments of the pulmonary vascular tree to increase pulmonary vascular resistance to blood flow. The physiological factors responsible for the differences in O_2 uptake by both lungs despite the maintenance of pulmonary blood flow during unilateral hypoxia, are discussed. (Authors' summary.)

776. Forster, R.E., Cohn, J.E., Briscoe, W.A., Blakemore, W.S. and Riley, R.L.: A modification of the Krogh carbon monoxide breath holding technique for estimating the diffusing capacity of the lung; a comparison with three other methods. J. Clin. Invest. 34:1417-26, 1955.

Measurements of D_{CO} were made at rest on 7 subjects by a modification of Krogh's breath holding technique. These findings were compared to simultaneous steady state measurements of D_{O_2} by the Lilienthal-Riley technique, of D_{CO} by the Filley technique and of fractional CO uptake as described by Bates. The latter methods were applied during exercise in 5 of the 7 subjects. All but one of the subjects were hospital patients and together they provided a wide range of values for pulmonary diffusing capacity. It is concluded for the present that the methods for the estimation of steady state D_{O_2} and D_{CO} provide similar values when allowance is made for the difference in physical characteristics between the 2 gases. Estimates obtained by the CO breath holding technique at rest show directional changes which are comparable to those obtained by the other methods during exercise, although the absolutevalues are lower. The fractional CO uptake, when uncorrected for changes in ventilation rate, is less reliable. The optimum conditions for each method vary, and further studies of the advantages and limitations of each are required. (Authors' summary.)

777. Girard, J., Sadoul, P., Le Fillattre and Graimprey, J.: Les moyens d'étude de la ventilation pulmonaire. Limites de confiance. (Methods of testing pulmonary ventilation. Limits of accuracy.) Toulouse méd. 56:569-77, 1955.

In the study of the reliability and accuracy of certain lung function tests, the Laboratory for Respiratory Function Research (Laboratoire d'Exploration de la Fonction Respiratoire) at Nancy carried out, during the last few years, >8,000 spirographic determinations, both in normal subjects and in those showing pathologic changes. Many of them were followed up 3-15 times, for periods extending over 2-6 yr. The author mentions some methods in use, e.g., measurement of thoracic expansion on both inspiration and expiration as well as radiologic and radioscopic studies and discusses various pulmonary function tests with regard to the variation coefficient.

The values obtained from testing 474 normal, male subjects, ranging in age from 15 to 75 yr., are summarized in tabulated form, with respect to their performance of: vital capacity (V.C.) and first second timed vital capacity (T.V.C.). From a comparison of all methods of pulmonary function testing discussed, the author concludes that determination of V.C., T.V.C. and residual volume provide the most valuable information for the detection of respiratory insufficiencies.

778. Hatch, T. and Cook, K.M.: Partitional respirometry. A system for measuring pulmonary functional capacity in terms of its elements: ventilation, diffusion, blood flow. Arch. Ind. Health 11:142-58, 1955.

A method of partitional respirometry is proposed for measuring the gas exchange capacity of the cardiorespiratory system, whereby the over-all pulmonary function is broken down into its elements--ventilation, diffusion and blood flow, and the relative contribution of each to the gas exchange capacity is determined. Treating the cardiorespiratory system in the physical and mathematical terms of a gas-liquid equilibrating apparatus, it is shown that the rate of uptake of an inert gas can be expressed in proportion to an over-all transfer coefficient, U, the value of which is determined by an appropriate summing of the ventilation rate, diffusion capacity and blood flow. Depending upon its solubility in body fluids, a gas is absorbed through the respiratory system at a rate which is primarily dependent upon 1 or another of the 3 elements and is independent of atleast 1 of the others. From the determinations of U for 3 selected gases it becomes possible to calculate the values of V_e, D and B_e, the effective rates of ventilation, diffusion and blood flow. Partitional respirometry makes use of 3 test gases: (1) ether, which is retained mainly in proportion to ventilation, is only slightly dependent on blood flow and is independent of diffusion; (2) acetylene, which is retained in proportion to ventilation and blood flow but is independent of diffusion and (3) CO, which is retained in proportion to ventilation and diffusion and is independent of blood flow. These are inhaled by the subject in physiologically acceptable concentrations. Apparatus and test procedure for measuring rates of respiratory uptake and calculating U for these gases are described, and results from tests on a series of subjects at rest and with graded rates of exercise on a bicycle ergometer are presented. 4 classes of subjects were distinguished: 6 young men in good health (age 26-33 yr.), 2 football players, in active training (19 and 21 yr.), 8 older men (age 45-76 yr.), all active, but in varying degrees of physical conditions and 9 men (age 56-72 yr.) with respiratory impairment and with a history of >25 yr. of coal mining, as well as 2 ambulatory patients from a t.b. hospital. U_{ether}, $U_{C_2H_2}$ and U_{CO} vs. rate of lung ventilation are graphed for each class of subjects, and V_e, D and B_e are calculated. The results suggest that, by the method of partitional respirometry, pulmonary functional capacity can be usefully described and

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Hatch, T. and Cook, K.M. (continued)
significant measurements obtained of the effective rates of lung ventilation, gas transfer by diffusion across the alveolar wall and pulmonary blood flow. Possibilities for determining the nature and magnitude of respiratory impairment and for distinguishing between losses in ventilatory, circulatory or diffusional capacity are also suggested. A procedure is developed for calculating the capacity of the cardiorespiratory system for exchanging O_2 and CO_2 from the results obtained by partitional respirometry. It is realized that this analysis of O_2 and CO_2 exchange is oversimplified, but the results appear to be useful in illustrating the factors involved in the process and in suggesting interesting possibilities in this study.

779. Leuallen, E.C. and Fowler, W.S.: Maximal midexpiratory flow. Am. Rev. Tuberc. 72:783-800, 1955.

A ventilatory test of widely acknowledged utility is the performance of a maximally rapid and deep expiration. Disagreement exists on the characteristics of the pattern of flow and on the method of measurement. The study of pneumotachograms of healthy adults and of patients who had pulmonary emphysema confirmed the presence of large accelerations of volume during the first several tenths of a second; these accelerations make accurate recording by spirometers uncertain. However, the mean rate of flow and the time required for expiration of the middle 50% of the total volume expired (maximal midexpiratory flow and midexpiratory time) could be recorded accurately by a spirometer of the conventional Benedict-Roth type. The expiratory retardation found in adult patients with chronic bronchitis or emphysema was found to be most pronounced during expulsion of the midpart of a maximally deep and rapid expiration.

Normal standards for maximal midexpiratory flow and midexpiratory time and measurements of the percentage of the total volume expired in 1 and 3 sec. were obtained from a study of 140 healthy persons of both sexes and various ages. An example of the clinical utility of these measurements, which are simply and rapidly made, is presented, based on observations on 100 patients who had chronic bronchopulmonary disease. Maximal midexpiratory flow and midexpiratory time were found to be more sensitive as detectors of obstructive impairment than were previously used tests, including vital capacity, the percentage of vital capacity expired in 1 and 3 sec. and maximal breathing capacity. The latter group of tests tends to give results that lead to an underestimation of the extent of obstructive impairment present.

In >2 yr. of daily clinical use, the measurements of maximal midexpiratory flow and midexpiratory time have proved to be simple and valuable. They can be determined with sufficient accuracy by means of spirometers and drum speeds which are commercially available. They are useful additions to the customary ventilatory measurements of vital capacity, 1-sec. percentage of vital capacity, and particularly when the latter tests give borderline results. (Authors' summary.)

780. Levine, E.R.: Some fundamentals of respiratory physiology. Arch. Internal Med. 96:357-9, 1955.

The author discusses the importance of considering the entire respiratory unit as an adaptive and compensatory mechanism. This is true in all major divisions of respiratory function: ventilation through tracheobronchial channels, gas interchange through the alveolar capillary membrane, circulation of blood through the pulmonary capillary bed from the right heart to the left auricle and the systemic circulation with gas exchange in the body tissues. Various examples illustrate how a very effective compensating function may take over the burden, in case of loss of one or of a

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Levine, E.R. (continued)
combination of several respiratory functions. Consequently, within rather wide limits of customary activity, there may be neither symptoms nor disability although a definite pathologic condition is present. The former appear only following a breakdown of the compensatory mechanism. The author emphasizes the significance of this complex of compensations and balances and the equally complex picture of compensation loss with regard to therapy. Frequently, signs and symptoms do not point to the source of the disturbance. As illustration, the author mentions dyspnea, which is present in lesions of the small bronchi and bronchioli, in pathologic conditions of the alveolar capillary membrane and in changes in the pulmonary circulation and resulting heart failure. In many cases, all 3 situations occur simultaneously, and each adds interference to the others. If any one is corrected, improvement is noted but lasting progress has not been made. It is for this reason that studies of the right heart and pulmonary circulation must accompany those made of pulmonary function. The therapy, which must be continued for months after the disappearance of the symptoms (for years in all chronic pulmonary conditions) should aim at bringing inactive lung areas and alveolar capillaries back to function. This increases the vascular bed, lowers pulmonary artery pressure and possibly produces a respiratory reserve. In the reestablishment of the compensatory mechanism lies the reason for improvement of apparently permanent and irreversible damage to the lungs.

781. Luft, U.C., Roorbach, E.H. and MacQuigg, R.E.: Pulmonary nitrogen clearance as a criterion of ventilatory efficiency. Am. Rev. Tuberc. 72:465-78, 1955.

A method is described for the determination of ventilatory efficiency from the clearance of N_2 from the lungs while breathing O_2. The total ventilation required for the clearance of pulmonary N_2 is dependent upon the lung volume and the efficiency of ventilation with regard to mixing and distribution of gas. The clearance equivalent, a measure of ventilatory efficiency independent of lung volume, is obtained by dividing the total clearance ventilation of the subject by the functional residual capacity which is measured in the same procedure. The clearance equivalent as measured in 37 normal males and females ranging from 12-64 yr. of age showed very small individual variations in healthy persons. 76 patients with pulmonary t.b. and various forms of nontuberculous pulmonary disease were studied with this method in addition to spirometry and other pulmonary function tests. The estimate of ventilatory efficiency based on the clearance equivalent was found to agree more closely with the clinical condition than any other single function test employed. On the average, the ventilatory efficiency of patients with pulmonary t.b. was lower than in any other category of pulmonary disease with the exception of bronchiectasis, in which it was of the same order. The measurement of ventilatory efficiency with the N_2 meter is proving to be a most valuable aid, not only in evaluating the status and prognosis of a patient, but also in estimating objectively the response to various types of therapy. (Authors' summary.)

782. Miller, R.D.: Current concepts in the diagnosis and treatment of pulmonary emphysema. Arch. Internal Med. 96:360-9, 1955.

The term "emphysema" is defined as applied to both the so-called diffuse obstructive or "hypertrophic" variety originally described by Leannec and to various other pulmonary conditions. With regard to diagnosis, the author discusses the typical symptoms as well as laboratory tests and clinical studies of pulmonary functions and interprets results obtained by the use of these examinations. Finally, treatment of pulmonary emphysema is

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Miller, R.D. (continued)
discussed with consideration of environmental factors, medical measures and physical methods, both the widely applied and those currently under evaluation.

In the conclusion, the author states that the clinical diagnosis of early pulmonary emphysema may be difficult because of the absence of many of the generally accepted criteria. The physiological alterations of expiratory slowing, increased functional residual capacity and underventilation of large portions of the lung often may be demonstrated by eliciting prolonged forced expiration, by evidence of decreased intensity of breath sound and by a failure of the amplitude of breath sounds to increase normally during hyperventilation. The limited understanding of the early pathogenesis of emphysema limits the possibilities of its early diagnosis and treatment. Once all the classic findings are present, the process frequently is self-perpetuating. Several simple basic therapeutic measures may afford most patients symptomatic relief and possibly slow the progress of this chronic disorder. These include avoidance of respiratory irritants, use of expectorants for patients who have tenacious secretions, suppression of nonproductive cough, judicious use of antibiotics in the control of complicating infections, exercises to promote abdominal breathing, emphysema belts for selected patients and the systematic use of aerosolized bronchodilating drugs. If these measures are not effective, more complicated procedures may be used, but their effectiveness in patients not responding to the simpler measures may be limited.

More intensive use of aerosolized bronchodilators, with limited amounts of O_2, is in order when respiratory acidosis occurs. Respiratory infections, which frequently precipitate such acidosis, must be controlled promptly. Mechanical respirators, if used under close observation, may help to provide the adequate ventilation that is important in severe cases.

Cor pulmonale appears usually after arterial hypoxemia develops. Therefore, in addition to the usual measure prescribed for congestive cardiac failure, use of O_2-generated aerosolized bronchodilating drugs is of particular value.

783. Minette, A.: Les variations de la capacité vitale et de l'expiration maximum seconde au cours de mesures repetées. (Variations in vital capacity and maximum expiration in the course of repeated tests.) Rev. belge pathol. et méd. exptl. 24:213-23, 1955.

Repeated vital capacity measurements were made of 30 medical students and nurses, untrained and in normal health (17 men and 13 women), ranging in age from 20-26 yr. 150 determinations were made in deepest inspiration and 90 in complete expiration, the subjects being in sitting position. The tests were carried out on 15 occasions, with a time interval averaging 6 da. between them, i.e., 10 vital capacity determinations and 6 maximum expiration measurements/test. The readings increased as the tests were continued, but not in a regular fashion; as much as 6% increase was due to an increase in both experience with the use of the apparatus and training of the subjects. Of the tests made, 4,381 gave satisfactory results. The average vital capacity (V.C.) values of the 15th, i.e., the last test, were about 6.2% higher than those of the first test, which was particularly noticeable in the first 3 determinations of the first test. The average values obtained in the latter 3 measurements were about 3.7% below the results of the whole first test. Under the stated conditions, variations of 2% in the readings were obtained from 4 subjects, 3-5% in 4 subjects, 6-10% in 10 subjects, 11-15% in 9 and 16-18% in 2 subjects. Variations in readings from 6-15% were thus noted in nearly 2/3 of the subjects tested. The determination results are graphically plotted in each case, and the variations

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Minette, A. (continued)
to be expected in testing a group of normal young people such as the described subjects are calculated mathematically.

784. Motley, H.L.: Pulmonary function in diseases of the chest. Diseases of the Chest 27:303-10, 1955.

This is a review of the lung function tests to be carried out in order to ascertain an accurate picture of the extent and location of the subjects' impairment in these functions, if any, and thus to provide valuable additional information to supplement that obtained from clinical examination. All procedures are described in detail, and the conclusions to be drawn from the results obtained are discussed, whether normal or indicative of pathologic changes.

An accurate evaluation of the degree of impairment of pulmonary function may be made from the following physiological tests. Ventilation measurements are carried out from spirogram tracings and include total vital capacity, 3 sec. timed vital capacity, maximal breathing capacity and the shape of the exhalation curve following a deep breath. Significant is the measurement of bronchospasms present. Another important basic measurement is that of the residual air capacity and alveolar N_2% after 7 min. of O_2 breathing. While the tests mentioned above demonstrate the action of the subject's chest and lungs, the second basic aspect of pulmonary function, viz., the blood gas exchange across the alveolar-capillary membrane, is evaluated from studies of the arterial blood and the expired air. For this purpose, the arterial blood O_2 saturation at rest and immediately after a step-up exercise is measured. The air expired by the subject is studied with respect to minute ventilation (total volume of air breathed during a test period of 3-5 min.), which, as a single measurement, is often indeterminate, as revealed by extensive statistical studies on a large series of cases, further, with regard to the O_2 uptake during the step-up exercise and to the % of O_2 extracted from the inspired air breathed. The character and duration of dyspnea after exercise provides valuable information as to the state of both pulmonary and cardiac functions.

The author states that great advances have been made in research investigations relating to pulmonary function in recent years, but many tests, though interesting, have yet to prove their clinical value.

785. Roos, A., Dahlstrom, H. and Murphy, J.P.: Distribution of inspired air in the lungs. J. Applied Physiol. 7:645-59, 1955.

Using the technic of continuous analysis of expired N_2 concentration after inspiration of O_2 in one or a series of breaths by normal and emphysematous subjects, a study has been made: (1) of the meaning of the respiratory dead space, as measured by this method and (2) of the influence of the time course of the respiratory cycle and of certain other factors upon the volume of the respiratory dead space, and upon the incorporation of fresh gas into the alveolar air content of the lung. The difficulty to establish a definite criterion for the first appearance of pure alveolar gas is demonstrated, and possibilities as to the nature of the transitional zone between gas from the conducting airways and from the alveoli proper are discussed. The importance is shown of diffusion for the reduction of the respiratory dead space which results from prolonging expiration time or from establishing an inspiratory pause. Similarly, the significance of intra-alveolar diffusion for alveolar ventilation is quantitatively demonstrated by means of studies during breath holding, slow expiration and moderate and extreme tachypnea. As much as 200 cc. of the inspired air may be incorporated into the alveolar gas by means of diffusion. Evidence is given that some lung regions may exchange with the rest of the lungs solely

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through diffusion. Finally, reasons are given why so-called 'stratified inhomogeneity' of alveolar composition may well play a significant part in the unevenness of lung ventilation. (Authors' summary.) (A careful piece of work of which the results carry conviction. MLT.)

786. Sadoul, P., Grilliat, J.-P. and Braun, P.: La bronchospirometrie ou separation des airs. (Bronchospirometry or separation of gases.) Poumon et coeur 11:939-68, 1955.

This discussion of bronchospirometry with regard to results obtained by the method, sources of error, complications and indications for its application follows a paper dealing mainly with historical aspects and description of both suitable equipment and procedure.

The author warns of indiscriminate use of bronchospirometry in cases where the gas exchange can be examined, without difficulty, by other means. The method is valuable for certain cases, e.g., in posttraumatic evaluation of impairment of the pulmonary functions. In other conditions, however, it is contraindicated, e.g., in cases of preceding hemoptysis, or where lesions of the trachea and of the left bronchus are present. Bronchospirometric examinations should also not be carried out when, by means of other studies, either greatly abnormal or, on the other hand, approximately normal values have been obtained. Bronchospirometry is particularly indicated and useful in cases of moderate impairment of the pulmonary functions, due to either chronic disease or trauma. It also may contribute valuable information as to the choice of therapy. These conditions are encountered in t.b. and in suppurating bronchopulmonary diseases.

787. Shepard, R.H., Cohn, J.E., Cohen, G., Armstrong, B.W., Carroll, D.G., Donoso, H. and Riley, R.L.: The maximal diffusing capacity of the lung in chronic obstructive disease of the airways. Am. Rev. Tuberc. 71:249-59, 1955.

The maximal diffusing capacity was measured in 27 subjects with chronic obstructive disease of the airways. Normal maximal diffusing capacity was found in the remaining 21 subjects. Correlation between the maximal diffusing capacity and lung volumes and ventilatory capacity was poor, suggesting that there need be no correlation between the degree of airway obstruction and severity of damage to the diffusing surface of the lung. This poor correlation may explain in part the discrepancies between estimates of severity of involvement by the clinicians, whose evaluation lays primary stress on the degree of airway obstruction, and the pathologist, whose evaluation lays primary stress on the extent of disintegration of the walls of the alveoli. (This is an excellent paper. MLT.)

788. Wilson, R.H., Hoseth, W. and Dempsey, M.E.: The effects of breathing 99.6% oxygen on pulmonary vascular output in patients with pulmonary emphysema and chronic hypoxia. Ann. Internal Med. 42:629-37, 1955.

Twenty-one patients, average age - 56.3 yr., with severe chronic diffuse pulmonary emphysema and chronic hypoxia were selected for study of the effect of breathing 99.6% O_2 on the cardiac output, pulmonary arterial pressure and total pulmonary vascular resistance. The average cardiac output changed from 5.53-4.84 l./min. There was a highly significant correlation between the mean total cardiac output and total mean pulmonary vascular resistance on ambient air and O_2. The mean total pulmonary vascular resistance decreased from 417.2-366.4 dynes cm. sec.$^{-5}$, after breathing O_2 for 20 min. The mean pulmonary arterial pressure also decreased from 25.2-19.9 mm. Hg because of (1) the fall in cardiac output and (2) the diminution of pulmonary vascular resistance. The mean pulmonary

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arterial wedge pressure decreased slightly but significantly from 5.6-4.03 mm. Hg while breathing 99.6% O_2. Pulmonary arterial hypertension in patients with chronic pulmonary emphysema is not primarily due to hypoxia, but is caused by the loss of large areas of pulmonary alveolar tissue and capillary plexuses and sclerosis of the pulmonary arterioles, leading to a great diminution of the volume of the pulmonary vascular bed.

789. Miller, W.F., Johnson, R.L. and Wu, N.: The half-second expiratory capacity test: a convenient means for evaluating the nature and extent of pulmonary ventilatory insufficiency. Diseases of the Chest 30:33-42, 1956.

A simple method employing single maximum expiratory efforts is presented as a means of defining the nature and extent of ventilatory insufficiency. The method involves the measurement of the 0.5 sec. expiratory capacity and the total vital capacity. Then by relating the 0.5 sec. expiratory capacity to the total vital capacity as a simple ratio, an expression of the maximum velocity of air flow during expiration is obtained. The total vital capacity is a measure of maximum pulmonary stroke volume. Thus, in a single test, expressions of the velocity of pulmonary air flow as well as pulmonary stroke volume are found. If these functions are plotted against each other, in a quadrant graphic system which is based on the normal values for these functions, a convenient method for defining the physiological nature of ventilatory insufficiency is obtained. This test is applicable even to the seriously debilitated patient who cannot perform the maximum breathing capacity test. Serial studies by this method provide a convenient and informative method of studying the nature of the change in ventilatory function during the course of the disease or resulting from therapy.

790. Woolf, C.R., Gunton, R.W. and Paul, W.: Simple tests of respiratory function using a direct-writing ear oximeter. Am. Rev. Tuberc. 74:511-32, 1956.

A "direct-writing" ear oximeter, containing one lamp, 2 filters and 2 Se photocells and operating an ink-writing Esterline-Angus milliammeter, was used to record changes in arterial O_2 saturation in 65 subjects (34 with normal lungs, 31 with pulmonary diseases) during O_2 breathing, hyperventilation and exercise. The subjects, 47 males and 18 females, ranged in age from 19 to 71 yr. and were divided into 5 groups with the following average ages: (1) normal, 28 yr., (2) hospital patients with normal lungs, 41 yr., (3) patients with light pulmonary abnormalities unlikely to interfere with function, 42 yr., (4) patients with pulmonary abnormalities other than emphysema, 42 yr. and (5) patients with emphysema, 52 yr. The accuracy of the procedure and recording was checked by double tests of the same subject. In the respiratory function tests, a Collins respirometer was used. For MBC values, the air was collected in Douglas bags. The rise of arterial O_2 saturation during O_2 breathing was, on the average, slower in patients with emphysema than in other subjects; but, when expressed as "90% saturation time (S.T.)," it showed considerable overlapping of results obtained from normal and abnormal subjects. The test was not accurately reproducible (S.D.± 25.8% of the average of 128 tests). The defects were not corrected by relating the 90% S.T. to O_2 consumption and volume of O_2 breathed during the test. On the other hand the "90% desaturation time (D.T.)" test results distinctly separated the patients of group 5 with or without pulmonary fibrosis from those belonging to all other groups, i.e., the former had a 90% D.T. of >300, often even >400 sec., the latter had one of <300 sec. These tests were reproducible with higher accuracy (S.D. ± 12.5% of the average of the 124 tests). This prolongation of the fall of arterial O_2 saturation in emphysema patients, when changed from breathing

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O_2 to breathing air, was probably due to inefficient gas mixing. During 15 sec. of hyperventilation, all subjects had increased arterial O_2 saturation, demonstrating the very limited value of hyperventilation indeces for assessing the degree of respiratory disability. During a 1-min. 30-step (20 cm. high) exercise test, most subjects had a fall in arterial O_2 saturation: groups 1-3, 3.8%, groups 4-5, 15.6% and 17.0%, respectively.

The oximeter tests, simple to perform and convenient for the subject, gained in value when combined with ventilatory function tests. (28 references.)

SEE ALSO: Dechoux 570; Gilson 581.

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